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Front Cover : Blue tailed Bee-eater with feed *Photo by* : M. N. Jayakumar, IFS

Back Cover : Elephant herd at the Banks of River Kabini *Photo by* : M. N. Jayakumar, IFS

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RESCUE OPERATION OF INJURED WILD TIGER AT RAJIV GANDHI NATIONAL PARK AND ITS REHABILITATION AT SRI CHAMARAJENDRA ZOOLOGICAL GARDENS, MYSORE

DR. S. S. M. S. KHADRI[1], DR. S. C. VALANDIKAR[2], SRI KUMAR PUSHKAR, I.F.S.[3]

ABSTRACT

The paper deals with effort of forest staff in locating an injured tiger with an aim to treat. The process of locating, tranquiling pre and post operative methods and rehabilitation is described in detail.

Introduction

A wild male tiger aged about 8 years, was seriously injured in its left fore limb by a jaw trap laid by the poachers. The video footage taken by a Jungle Lodges Wildlife Tourist, helped Forest Department Staff to Conduct intensive combing operation, rescued the injured tiger, and shifted to Sri Chamarajendra Zoological Gardens, Mysore, to provide necessary treatment for its rehabilitation.

Rescue Operation

On 31st May 2002 staff of Forest Department of D. B. Kuppe range noticed a wild tiger limping due to an injury in its left fore limb. The video footage taken by wildlife tourist, was telecasted in various news channels, clearly showing jaw trap in the left fore limb. The Principal Chief conservator of Forests (Wildlife Preservation) Mr. Chakrabarthi, I.F.S., mobilized all the concerned staff, wildlife veterinarians and kumki elephants etc., to start the rescue operation. It was a challenging job to locate the injured male tiger because of the dense under growth of Lantana and other vegetation. On 2nd July 2002 Conservator of Forests Sri Annur Reddy was able to track the injured Tiger in the evening, but could not dart the tranquilizer as it was getting dark. On 6th of June 2002 morning Tribal Trackers were able to find the den where wild injured tiger had taken the shelter in Mastigudi section of D. B. Kuppe range. The den was ideally selected by the injured tiger and it was located very close to back water of Kabini reservoir. Perhaps the tiger was surviving on water, as it is impossible to make kill due to serious injury in its fore limb.

The mouth of the den measured 2½ feet in width and it was gradiating down to about 5 feet, which will lead to a chamber

1 Veterinary Officer, Mysore Zoo.
2 Asst. Director, Zoo Hospital, Mysore Zoo.
3 Executive Director, Mysore Zoo.

sufficient to accommodate adult tiger. The mouth of the den was closed by spreading a net and observation was made. Though it was aggressive, it did not move on approaching the dens mouth. For safety reasons, Iron grill gate was used and placed over the net. This facilitated to look into the semi dark environment of the den under the torch light. We could see the head and the right limb. The injured left limb was covered. The animal was disturbed with the help of a pole and it moved exposing the left limb. It had a serious injury infested with maggots. Meanwhile two holes were drilled from above into the den to allow more light for observation. The rescue cage was positioned attached to the mouth of the cage and crackers were busted. Though it was agitated, it resisted to move. Water was poured into drilled holes to flush the tiger out into the rescue cage but it didn't work. It was getting dark. Therefore it was decided to tranquilize the animal. Dr. Khadri darted the tranquilizer to the right shoulder under the light of the torch. The symptoms of sedation was noticed within 10 minutes and then the tiger was noosed through shoulder and the neck and gently pulled into the rescue cage. It was around 8.45 p.m. the cage was slowly shifted with the help of the staff and loaded on the transporting truck. The wound was washed with antiseptic and examined. The trap had caused serious injury severing all the toes along with the paw. An open septic wound contaminated with soil and infested with maggots could be seen. First aid treatment was provided. As the Tiger was fasting, since almost 6 days without getting any food due to the injury we offered 5 kgs of chicken, which it ate completely. The Conservator of Forests, Madikeri circle, Sri Annur Reddy, I.F.S., and Deputy Conservator of Forests, Hunsur Division, Sri Annaiah, I.F.S., decided to shift the injured tiger to Sri Chamarajendra Zoological Gardens, Mysore for further treatment. The tiger was shifted to Mysore Zoo on the same night and reached the Zoo at 3.00 a.m.

Treatment at Mysore Zoo

On the 7th of June morning it was tranquilized using Ketamine Hcl 600 mg & Xylazine 100 mg in Combination injected manually as the animal was kept in the squeeze cage. Induction time 15 minutes, under sedation the injured limb was examined thoroughly. The wound was disinfected, maggots and dead tissue were removed. The wound was flushed with metronidazole and anti septic wokadine solution. Inflammatory condition of the affected limb was noticed and the animal had the fever, body temperature being 104.5° F. It was decided to treat the animal with antibiotics, analgesic and anti-inflammatory agents to control the infection, before taking the surgical amputation of the affected limb. The infection was brought under control by giving Megamycin (amoxacylin) + (cloxacylin) 1.5 gms twice a day I/M along with voveran (diclofenac sodium) 1mg per kg body weight I/M two consecutive injections in two days were provided.

On the 3rd day, the body temperature returned to normal 100.5° F and inflammation of the limb also got reduced. Daily dressing of the wound was attended. On 14th June it was decided to amputate the

affected limb at the lower end shaft of radio-ulna bones.

Amputation of the effected limb

Team of doctors – Dr. Vasanth Shetty, Professor, Dept. of Surgery, Dr. Ranganath, Asst. Professor, Dept. of Surgery, Veterinary College, Hebbal, Bangalore, Dr. Shadakashar Murthy and the Zoo Veterinarians – Dr. S. C. Valandikar, Asst. Director and Dr. S. S. M. S. Khadri, Veterinary Officer attended the surgery of the injured wild tiger. The tiger was sedated using ketamine Hcl 700 mg and Xylazine Hcl 200 mg (estimated weight of the tiger 150 kgs) under sedation it was shifted to the operation theatre. Mobile x-ray unit was mobilized from Mysore Race Club equine dispensary and radiographs of the affected limb was taken before conducting the operation.

Zoo vets Dr. S.C. Valandikar and Dr. S.S.M.S. khadri monitored the anesthesia, pulse, respirations and body temperature, while Dr. Vasanth Shetty, Associate Professor, conducted amputation of the injured limb at radio-ulna at lower end of the shaft. Supplementary dose of tranquilizer was necessary, ketamine 100 mg and xylazine 25 mg was injected to prolong the sedation for completing the surgical operation. It took about 2 hours and 10 minutes to complete the amputation of the affected left fore limb. Noticing the recovery symptom like twitching of ears and palpebral and pupillary reflexes the tiger was immediately shifted from operation theatre to squeeze cage. For revival procedure Antagozil 2.5 ml and Doxapram 2 ml was given I/M. After about 20 minutes the animal recovered from sedation and took to the sternal recumbency. Post-operative care and treatment was continued and it took about two weeks for healing of the surgical wound and later another two weeks for its complete recovery. The animal is keeping good health and its appetite is normal. 10kg of beef, 1kg chicken and about 1/2 kg liver is being provided (liver twice in a week). Hygienic environment is provided all around the squeeze cage to avoid flees, which may cause maggots infestation.

Rehabilitation

The rescued wild tiger is presently housed at Mysore Zoo and can be exhibited after creating necessary exhibit facility for educational purpose to bring awareness among the Zoo visitors to convey the information of the danger being caused by the poaching of wild animals for their skin and bones. The jaw trap used for the attempted poaching of this wild tiger will also be displayed in front of the exhibit for it may convey the message of the seriousness that this species is going towards extinction unless and otherwise protection and conservation measures are seriously taken.

Acknowledgement

We sincerely thank the team of surgeons, Dr. Vasanth Shetty, Dr. Ranganath and Dr. Shadakshar Murthy of Veterinary College, Bangalore and Govt. Poly Clinic Mysore, for their co-operation in surgical intervention in amputation of fore limb of Royal Bengal Tiger.

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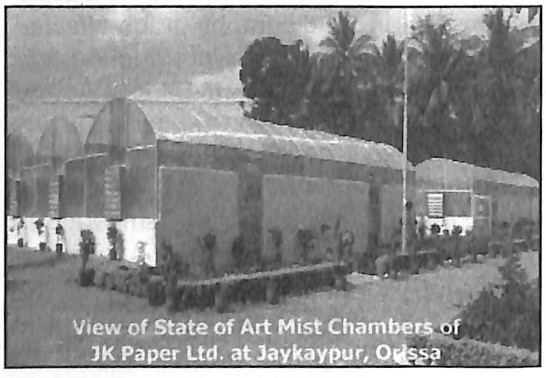

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AN "ELEPHANTINE" TRAGEDY

ANNU REDDY, I.F.S.*

ABSTRACT

The article deals with the status of elephant population and the impact of man-animal conflict on them. As Kodagu district has been taken as a model district to illustrate the present status of tragedy faced by elephants and their habitat.

Introduction

The winds of discontent blowing across the pachyderm countryside in the last few years have crystallized into an allround conflict of mammoth proportions. In the states of South India, irrespective of the number of elephants a habitat has, resulted in a confrontation with man. In this on going/continuous attrition elephants sadly are at the receiving end and their populations are being threatened.

Going back into the history of pre-independent India with its large tracts of undisturbed wilderness, had ensured a continuous habitat for elephant populations. They rarely strayed out of their forests and contact with man was limited and if any, if was not fatal. A few elephants were captured for timber operations being trained by the tribal mahouts and a few were maintained by the Maharaja to declare to the world their prosperity. The number of elephants were never alarmingly high so as to threaten human life.

Post-independent India saw a number of changes many of them not very conducive to wildlife conservation. Large tracts of forests were converted to agriculture. Big river valley projects to generate power and irrigation facilities devastated huge expenses of wilderness areas. Added to this the human population increased tremendously putting pressure on the limited land resource. As a progressive country we got into this "Development Syndrome" wherein a lot of effort, time and money was invested in the "Developmental Programmes" which had a negative impact of wildlife and wilderness areas. Increase in human population fuelled their materialistic needs and desires. More people meant more forests being diverted for their allround rehabilitation. Wildlife habitats were encroached, fragmented and became unviable. The irony of it was though as a nation culturally we idolised wildlife especially elephants, as people we were destroying their last refuge; large expenses of undisturbed, uninhabited, uncultivated forest habitats. People who pray to them in their houses have started killing them in their farms, estates and dwellings.

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* Conservator of Forests, Wildlife Conservator.

The conflict and the resulting tragedy

Whether it is Karnataka, Tamil Nadu, Kerala or Andhra Pradesh irrespective of elephant numbers the conflict has assumed alarming proportions.

Taking an example of Kodagu district in Karnataka, which is an ideal elephant country, the anguish and anger of this conflict and confrontation is pouring on to the streets with tempers running high and tolerance levels touching an all time low.

Kodagu district with an area of around 4100 sq. kms. has nearly 30% of the area with the forest department with good tree cover. Though much of these areas were worked in the past to support the plywood industry as per the prevailing norms then, the rest given to these areas in the last couple of decades has seen a general spurt in natural regeneration with areas slowly recouping from this onslaught. Much less 30% of the land was under various forms of cultivation either coffee, paddy, bananas, spices, etc. More than 30% of the land was under tree cover to be maintained in perpetuity as a privilege to the cultivated land to get green manure, fodder and small timber.

The legal status of forests were (in hectares):

i)	RF	1,13,646	(90.23%)
ii)	PF	2,714	(2.15%)
iii)	Unclassed	9,592	(7.62%)

Devarakaadus, Urudve, Mandus, Ambalas, etc., form the protected forests. The lands coming under the district forests in Kodagu were Bane, Kharab, Paisari, Parampoke forest, Jamma Malais and other government lands, which were more than 1,000 sq. kms. Bane lands were nearly 1,27,403 ha. Paisari lands were around 69,711 ha. Jamma Malais were nearly 3,239 ha. All these areas were like forest areas with good tree cover.

Thus Kodagu district was an ideal elephant habitat with large tracts of forests and tree cover areas interspersed with estates.

Elephants by habit were migrating in nature from Nagarhole upto Bhadra and back. There was not much damaged caused because of this migration in search of food and water.

Post-independent India in the 1970's and 80's saw a spurt in estate activity with expansion of coffee area by locals and a number of people coming across the border.

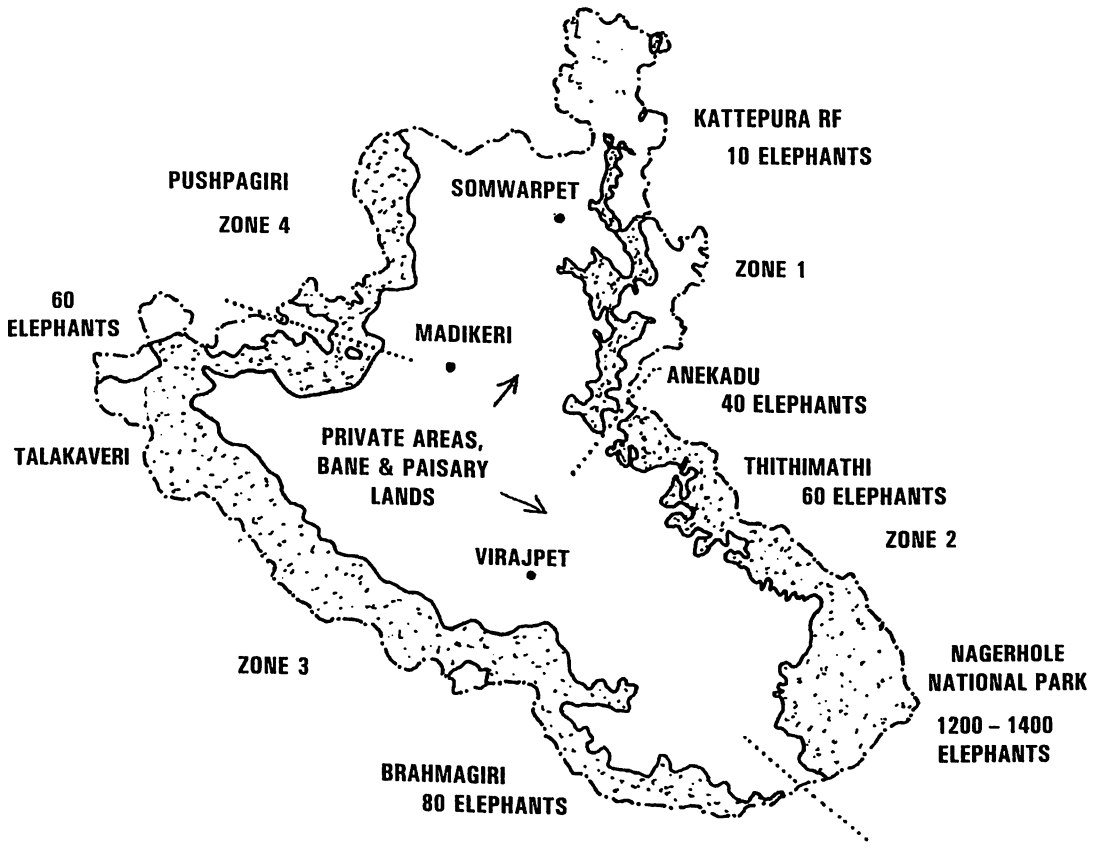
Most of the district forests like Bane, Paisari and other government lands were encroached and converted to coffee. The old habitat of elephants and other wildlife was fragmented and was no longer available for wildlife. They became aliens in their own land, which they were inhabiting and migrating to and fro for hundreds of years. Irrigation Dams have also added to the problem. The bigger estates have put up power fences and have blocked the path of the elephants. Only the reserve forests and the wildlife sanctuaries are left forming a necklace around the estates. The situation is fraught with disaster as their habitat has become highly disturbed and cultivated.

For no fault of theirs they are at the receiving end of anger, anguish and bullets.

Government pays a compensation of around 15 lakhs each year. About 6-7 people are killed on an average every year. About 6-7 elephants are also killed each year in this man animal conflict.

Elephants across the country are being hounded out of their habitat. The scenario is same in Andhra Pradesh, Tamil Nadu and Kerala. The actors are different, the drama being enacted varies, the end result; elephants are in a precarious position.

When one views the overall situation, we need to make a few sacrifices, develop greater tolerance, towards wildlife so that we can co-exist.



WILD ELEPHANT ELECTROCUTED

WILD ELEPHANT CAPTURED

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EX-SITU CONSERVATION OF SWAMP DEER *{CERVUS DUVAUCELI}* - A CASE STUDY AT SRI CHAMARAJENDRA ZOOLOGICAL GARDENS, MYSORE

SRI KUMAR PUSHKAR, I. F. S.[1], SRI SHIVANNA[2]
DR. S. S. M. S. KHADRI[3]

Introduction

Swamp deer or Barasingha inhabits Terai region of Uttarpradesh, Assam and the Sundarbans distinguished by its splayed hooves and larger skull *{Cervus duvauceli}* and branderi race found in the hand open ground of Madhyapradesh with smaller well knit hooves *{Cervus duvauceli branderi}* (S.H. Prater - 1971).

Mysore Zoo houses *(Cervus duvauceli)* of Terai region. Their habitat in Assam is in high ground in the proximity of water. They are highly gregarious, less nocturnal than Sambar. They feed till late in the morning and again in the evening and rest during the day. They prefer reeds and other plants of the swamp; they also eat grass, herbs, leaves and buds. (Bernhard Grzimek - 1972).

The swamp deer is a schedule species classified as Schedule-1 under the wildlife protection act 1972 and considered as highly endangered needs protection in free range and *Ex-Situ* conservation efforts at zoos.

Distinctive Characters

The summer coat is amber to golden brown in colour with pale spots. The antlers are beautiful reaching a length of more than one meter; they look better proportioned and elegant in matured stags. Each antler usually have 6 tines and with both the antles, there will be 12 or more tines, giving the popular name to this species as "Barasingha". The adult male stag measures 4-5 feet at the shoulder and weigh around 150-200 kgs.

Feeding in Captivity

A balance diet, meeting all the requirements of carbohydrates, fats, proteins, trace minerals, essential amino acids, vitamins and water are given in hygienic condition. The food is checked at the store level and at the enclosure level on daily basis to ensure right quantity and quality of the food items. Feeding and watering troughs are provided within the enclosure. The concentrates used in the diet and the roughages issued per adult animal is as follows :

Concentrates

1. Wheat bran	2.0 kg
2. Horse gram	0.4 kg
3. Ground Nut cake	0.1 kg
4. Bangal gram	as and when required

Roughages

1. Hay	02.5 kg
2. Green grass	10.0 kg
3. Branch fodder	05.0 kg

1. Executive Director, Mysore Zoo.
2. Junior Administrative Assistant, Mysore Zoo.
3. Veterinary Officer, Mysore Zoo.

Healthcare Management

Supplements

1. Kemp trace dry

   A blend of organic minerals, with viable yeast and vitamins
   Adult stag 15 grams
   Adult female 10 grams

2. Ostocalcium + Vimeral
   (Ca, P, Vitamin D_3 and B_{12}) + (Vitamin A + D_3 + E + B_{12})

Deworming

Deworming is attended every 4th month and three times in a year with either Albendazole or Fenbendazole Broad spectrum Anthelmentics.

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Vaccination

The captive population of all deer species including Swamp deer are susceptible to bacterial and viral diseases. Foot and Mouth (Viral) disease and hemorrhagic septicemia (Bacterial) endemic to this region, animals are vaccinated whenever they are tranquilized and restrained.

The Swamp deer are regularly monitored on daily basis by the keepers and Zoo Vets. In case of illness or trauma they are chemically restrained and taken to the holding room and treatment is provided.

Enclosure Enrichment (Micro Captive Habitat)

Mysore Zoo has declared year 2003 as an enclosure enrichment year (captive habitat). Apart from good nutrition, hygiene and health care we need to provide semi natural-to-natural environment required for the concerned species within the enclosure. The enrichment has got many advantages in the management of captive wild animals. It reduces stress and animal get withdrawal area for rest and relaxation. It also stimulates natural behaviour and provides psychological satisfaction to the animal.

The enclosure for Swamp deer at Mysore Zoo has a water pool to create swampy area, for wallowing of the animals, having natural substrate. The withdrawal area has good number of rain trees providing shade and shelter to the animals. Natural camouflage material in the form of tree branches and leaves has been provided to shelter young fawns. This has reduced infant mortality due to trampling and attack by any predator free ranging animals. During rainy season the upstream Karanji Tank seepage flows into the Swamp deer enclosure making it a very ideal naturalistic enclosure to the species.

Breeding Success

2 pairs of Swamp deer were received from the prince of Wales Zoological Trust, Lucknow during July 1991. The stock started breeding from 1993-1994, Young fawns are born almost every year indicating good management practices (housing, nutrition and health care) and environment they are housed. 27 births were recorded. Mortality in young fawns is due to trampling and rejection of young ones by the mother. Death in adults is recorded due to infighting trauma, old age, dystocia (difficulty in parturition) and other non-specific causes.

Sl. No.	Year	Birth	Acquisition	Death	Total	Total Stock
1	91-92	0	4	0	4	4
2	92-93	0	0	0	0	4
3	93-94	2	0	0	2	6
4	94-95	2	0	0	2	8
5	95-96	2	0	0	2	10
6	96-97	3	0	2	1	11
7	97-98	3	0	0	3	14
8	98-99	2	0	1	1	15
9	99-2000	3	0	3	0	15
10	00-2001	4	0	1	3	18
11	01-02	0	0	0	0	18
12	02-03	5	0	3	2	20
13	03-04	1	0	2	-1	19

Presently Mysore Zoo has 19 Swamp deer (7 males, 11 female & 1 unknown young fawn) as in the inventory stock. We would like to distribute surplus stock to some of the zoos in exchange programme.

Conclusion

Indigenous endangered species can be bred in captivity providing suitable environment, balanced nutrition and good health care. The captive population of endangered species, free from diseases can be shifted to herbivorous safaris in a large enclosure. Removing biotic interferences and conditioning them in natural environment over a period of time can facilitate the animals for reintroduction in natural habitat.

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MASS TRANQUILISATION OF SPOTTED DEER (AXIS AXIS) AND THEIR SHIFTING TO ARABITITTU RESERVE FOREST

DR. S. S. M. S. KHADRI[1], DR. S. C. VALANDIKAR[2]
SRI KUMAR PUSHKAR I.F.S.[3]

Introduction

Sri Chamarajendra Zoological Gardens, Mysore is housing more than 375 spotted deers in 3 different enclosures. As they are prolific breeders, their population greatly increased over a period of time. Because of the over population, the infighting among the stags during the rutting season and competition for feeding and space resulted in increase in the mortality rate of the captive Spotted deer. To control their population we had taken up castration of few selected dominant stags using Burdizo castrator, under sedation. But it is not possible to control the prolific breeding of spotted deer in a high-density enclosure by this method. Hence a thought was given for the mass tranquilization of spotted deer and their shifting to isolated patch of Reserve forest, Arabitittu, in the outskirts of the Mysore city.

The over population of spotted deer, apart from causing stress and increasing the mortality due to infighting trauma, is very expensive to maintain them in captivity.

Methodology

Tranquilization of deer for treatment, crating and other procedures is generally carried out using Ketamine HCl in combination with Xylazine. For mass shifting of 300 spotted deer the regular procedure of darting each animal with said drug combination is cumbersome and very expensive. Each dart syringe along with said drug combination costs about Rs. 2000.

The mass tranquilization of spotted deer using Diazepam (Valium 10mg tab) was adopted at Sri Chamarajendra Zoological Gardens, Mysore. On trial basis under control measures Diazepam was given 0.85 grams to 2 grams along with the food for each spotted deer (Harthoorn A.M., 1976). It was observed that Diazepam 2 grams brings ideal sedation, which allows manual restraining on approach. The symptoms of sedation could be noticed up to 36 hours and animals recover on their own. It was decided to take up field trials using Diazepam, at the rate of 2 grams per spotted deer for achieving desired degree of sedation for shifting.

On 14th Nov. 2002, Diazepam (valium 10 mg tab) X 2000 tabs was mixed in five kgsof concentrate feed and made into 1 equal parts and kept separately in

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a holding area. Six spotted deer 1:5 consumed the full quantity of the medicated food in the holding room. Symptoms of sedation like ataxia could be noticed after 45 minutes. After about 4 hours in coordination of limbs, drowsiness, half closed eyelids with bending of neck was noticed. Finally the deer could come down on the lateral recumbency after about six hours. Two of the female deer showed insufficient sedation, may be because they had taken partial quantity of the medicated food, and showed little resistance on manual approach. The said deer were given Ketamine HCl 1 ml (100 mg) intramuscularly to achieve desired sedation. All The sedated deer were safely taken to the transporting truck and shifted to Arabitittu reserve forest.

On 15th Nov 2002, it was decided to feed medicated food in the afternoon around 4 PM to achieve desired degree of sedation by next day morning, which allows manual restraining with out causing stress and strain to the animals. Eleven Spotted deer were taken to the holding room and given medicated food at the rate of 2 gram Diazepam per animal. Next day morning (16th Nov 2002) at 7:30 am observation was made. All the deer were showing good degree of sedation and allowed manual approach without any excitement. All the eleven (3:8) spotted deer were secured manually and taken to the transporting truck and shifted safely to Arabithittu Reserve forest.

The Arabitittu reserve forest has free ranging leopards, which unfortunately had the field day to attack six of the spotted deer, which were still not completely recovered from the sedation. As it had been noticed during the controlled trials that the sedation with Diazepam could continue even upto 36 hours. Hence the deer shifted under sedation can be taken to the holding area for at least 3 days and then they can be released to the free ranging habitat to avoid unnecessary attack by the carnivore animals.

Precautions

- Benzodiazepines (Diazepam) brings drowsiness, stupor, ataxia and hypothermia.
- The affect of the Diazepam can last for 24-36 hours.
- Diazepam have a very high therapeutic index, even 5-10 times the therapeutic doses do not produce significant CNS depression, fatalities are rare.
- Diazepam 2g/animal produces ideal sedation for manual handling, if animal consumes more than the therapeutic index even to the extent of 5 times the normal dose, it is well tolerated and does not result in fatality.
- The action of the drug is delayed because the deer are ruminant animals.

Conclusion

Mass tranquilization of the spotted deer using Diazepam is cost effective

method to shift surplus population of spotted deer without causing stress, strain, excitement and injuries to the animals. The methodology adopted at Sri Chamarajendra Zoological Gardens, Mysore has given a very successful beginning which may help to shift 300 surplus spotted deer to isolated patch of reserve forest of Arabitittu. No Mortality was recorded during the shifting operation procedure. The mass sedation using Diazepam can be safely employed in various zoos, safaris and deer parks for the safe shifting of surplus stock of spotted deer in the country.

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HAND REARING OF RESCUED INDIAN WILD ELEPHANT CALF AT SRI CHAMARAJENDRA ZOOLOGICAL GARDENS, MYSORE – A CASE REPORT

DR. S. S. M. S. KHADRI, DR. S. C. VALANDIKAR, SRI KUMAR PUSHKAR I.F.S.

ABSTRACT

A wild male Indian elephant calf about 3 weeks old was found deserted close to Nugu Wildlife Sanctuary. The forest department staff shifted the elephant calf to Sri Chamarajendra Zoological Gardens, Mysore for providing necessary treatment and to undertake hand rearing procedure. Considering the milk composition of cow elephant the combination of skimmed milk powder (fat free-protein rich) and Soya milk (containing Fat + Proteins + Carbohydrates + Vitamin B1 & B2 + Calcium and Iron) was selected for nursing the calf. Latter grain cooked ration (Ragi Gruel) was introduced apart from feeding the reconstituted milk. The growth increment, like gain in body weight and shoulder height were recorded. The calf adopted very well to the feeding schedule and presently it is five months 10 days old and keeping good health.

Introduction

On 9th June 2002, the forest department staff of Nugu Wildlife Sanctuary found the deserted wild Indian male elephant calf, about 3 weeks old in an agricultural field close to Nugu Wildlife Sanctuary. The calf had fallen accidentally into a shallow trench and was unable to negotiate to join the herd. The calf had gone weak and minor wounds were found on its body. Asst. Conservator of Forests, Sri S. N. Devaraj, shifted the calf to Mysore Zoo for immediate treatment and nursing care.

The male elephant calf was named as Gajendra was examined at Zoo Hospital and its general condition was found stable. The condition of the calf was very weak as it was not fed with its mother's milk. Minor wounds were dressed and external parasites (Lice) were removed.

The following was the general health condition of the calf:

1. Body temperature 98.5°F
2. Respiration 18/minute
3. Pulse 66/minute
4. Shoulder height 89 cms.
5. Body length 97 cms.
6. Body weight 75 kgs.

It was decided to shift the elephant calf to the Indian elephant enclosure for hand rearing procedure.

Facilities required for hand rearing and nursing care

The Indian elephant enclosure in Mysore Zoo has three rooms measuring 10 ft. x 10 ft. namely preparatory room, nursing room and keeper's room.

Preparatory room

All the food items meant for feeding of the elephant calf was stored in the Almirah and food was prepared under hygienic condition. The feeding bottle was sterilized for each feeding and thoroughly washed after the use and kept inside the vessel having boiled water.

The preparatory room was provided with following materials to cater the needs of feeding and nursing:

1. Table 3 ft. x 5 ft.
2. Almirah
3. Chairs – 2 Nos.
4. Gas stove
5. Electrical stove
6. Buckets 10 lts – 2 nos.
7. Water Cans 10 lts. – 2 nos.
8. Vessels 5 lts. 2 nos. with lids
9. Vessels 2 lts. 2 nos. with lids
10. Seeve – 2 nos.
11. Feeding bottles 1000cc – 4 nos.
12. Spoons (Small 4 nos., Big 4 Nos.)
13. Towels (Small 5 nos., Big 2 nos.)
14. Scissor
15. Registers for documenting feeding patterns

Nursing room

The calf was kept inside this room for resting, feeding and observation. Hay bedding was provided for the resting of the calf as the elephant calf goes to intermittent sleep between the two feedings. Provision of room heater was made for its use during cool night hours. Movement of the calf can be restricted.

Keeper's room

This room was provided for the use of keeper's to keep their belongings and to rest during night hours to facilitate effectively monitor feeding and to observe the calf and to provide sufficient exercise.

Hand rearing staff

Experienced zoo staff were given the responsibility to attend preparation of reconstituted milk and other food items for the nursing of the calf and to monitor it round the clock.

Gajendra developed good rapport with the attending staff and liked their company. It was very interesting to watch the behaviour of Gajendra taking the smell of the attendant and recognizing him immediately. It followed the attendant wherever it is taken for the walk within the Zoo premises to provide sufficient exercise both in the morning and in the evening.

Feeding

The Gajendra which was deserted accidentally by its mother when it was about 3 weeks old. Hence, the calf had consumed sufficient quantity of colostrum in its first week of suckling to its mother. It means that sufficient quantity of immunoglobins had been introduced into its system which is clearly an advantage in preventing many health problems.

To assess the feeding requirements, the body weight of the calf was taken which was 75 kgs on 09.06.2002. On immediate basis the forest department staff had given 500 ml of cows milk during its transportation from Nugu Wildlife Sanctuary to Mysore Zoo.

Taking into consideration the earlier experiences of hand rearing of elephant calves in Mysore Zoo, it is felt that the cows whole milk is not suitable for the nursing of the deserted young elephant calves, which invariably causes intolerance diarrohea, leading to dehydration and death. The fat percentage of cow elephant's milk varies from 0.63% – 9.00%, a protein contents varies from 1.9% – 3.00% and Carbohydrates 4% – 8%.

Keeping in mind the mortalities occurring due to intolerance to the cow's milk we decided to adopt a diet formulation, which contained :

1. ***Skimmed Milk Powder***

   (Brand Name : Sagar, Spray Dried, Net Weight 500 gms., 5.25 lts. of non-fat protein rich milk).

   To make the milk fluid, add 5 parts of water to 1 part of Skimmed Milk Powder.

   Skimmed Milk Powder spray dried 500 gms can be added to 5.25 lts. of water to make Skimmed Milk.

   The product is manufactured by Kaira District Co-Operative Milk Producers Union Ltd., Anand India.

   Care was taken to close the lid of the container immediately after the use.

2. ***Soyabean Milk***

   Brand Name : Lactosoy supplementary food (Imported and Marketed by Nilgiri Dairy Farm, 171, Brigade Road, Bangalore-1, presentation 200 ml packs plain flavor).

   Nutrition Facts :

   Serving size : 1 box (200 ml)

   Servings per box : 1

   Amount per serving calories 160 calories from fat 70.

Total Fat	8g	12%
Saturated Fat	4g	20%
Cholesterol	0mg	0%
Protein	4g	
Total Carbohydrates	18g	6%
Dietary Fibre	0g	0%
Sugars	13g	
Sodium	90mg	4g
Vitamin A	0%	
Vitamin B2	8%	
Vitamin B1	2%	
Calcium	4%	
Iron	4%	

3. ***Sugar is added to the reconstituted milk for developing taste to the drink***

   All the feeding was attended as per the time schedule and feeding was done with an imported calibrated feeding bottle of 1000cc attached with calf's nipple. (The bottles were received from Dublin Zoo of Ireland for hand rearing of Giraffe calves). The same bottles were found useful for the Elephant calf. The feeding pattern is given in **Table 1**.

Hygiene

It is necessary to ensure cleanliness in and around nursing and preparatory room. The attendant should thoroughly wash his hands before handling sterilized feeding bottles and other utensils. He should wear clean clothes while nursing the calf. Iteol antiseptic was used for keeping the environment clean and hygiene in and around the nursing area. The calf was given bath in lukewarm water on daily basis and provided necessary exercise.

Treatment

The calf was provided medicated bath with Delta methrine, brand name Butox.

Behavioural observation

Gajendra adopted to the feeding pattern to set his biological clock. It used to make vocal sounds demanding food on approaching the feeding time. It liked the company of human attendant during bathing, grooming, feeding, exercise and even during resting in its nursing room. It was able to recognize its attendant even if he is mixed up in a group. It is interesting to note that the calf's attachment with the keeper is like the relationship between mother and the calf.

Conclusion

A diet formulation of skimmed milk powder and soya milk was tried for the nursing care of a rescued Indian male elephant calf aged about three weeks. The calf was adopted well to the reconstituted milk (Skimmed Milk + Soya Milk + Sugar). Latter at the 2nd month of its age introduced Ragi flour gruel mixed with skimmed milk and sugar. Growth and development of the calf in respone to the feeding pattern was made by recording gain in body weight and increase in shoulder height. The weight gain of 25-30 kgs. was noticed per month and increase in shoulder height by 2-2.5 cms. We did not find any health problem during the nursing care period of 4 months and 11 days period. We would like to introduce roughages on completion of 6 months apart from feeding cooked grain ration and gradually reducing the quantity of reconstituted milk.

Present Diet Chart (August 2003) – Weight of the Animal – 355 kg

Sl. No.	Particulars	Grams 6:30 a.m.	Grams 9:00 a.m.	Grams 1:00 p.m.	Grams 5:00 p.m.	Total Grams per day
1.	Skimmed Milk Powder	100	100	100	100	400
2.	Soya Milk	200		200		400
3.	Ragi Flour		500		500	1,000
4.	Sugar	40	40	40	40	160
5.	Rice		200		200	400
6.	Carrots	0.5				
7.	Jaggery	100				
8.	Coconut	2 nos.				
9.	Sugar Cane	0.5 kgs.				
10.	Roughages/Reed Grass/Hay	2 kgs.				

Table 1 – Feeding pattern of rescued Indian Wild Elephant Calf at Sri Chamarajendra Zoological Gardens, Mysore from 9th June to 20th October 2002

FEEDING PATTERN

	Reconstituted Milk								
	← +(Three Feedings) →						(Two Feedings)		
Diet Contents	9th June	25th June	10th July	25th July	10th Aug.	25th Aug.	10th Sep.	25th Sep.	10th Oct.
Skimmed Milk Powder in Grams	100	135	175	200	250	250	250	250	300
Soya Milk in ml	100	135	175	200	200	200	200	200	200
Sugar in Grams	20	20	30	30	40	40	40	40	40
Total Quantity of Reconstituted Milk in Grams	660	870	1140	1290	1470	1470	980	980	1080
	Ragi Gruel								
		← (Three Feedings) →							
Ragi Flour in Grams		100	175	200	400	400	500	500	500
Skimmed Milk Powder in Grams		30	75	100	130	130	275	275	300
Sugar in Grams		20	30	30	40	40	40	40	40
Total quantity of Ragi Gruel in Grams		450	840	990	1710	1710	2445	2445	2520
Total quantity fed (including R.C. Milk + Ragi Flour Gruel) in Grams	660	1320	1980	2280	3180	3180	3425	3425	3600

FEEDING SCHEDULE

Diet	From 9th June to 25th August			From 10th June to 10th August		
Reconstituted Milk	7 a.m.	3 p.m.	8 p.m.	6 a.m.	2 p.m.	
Ragi Gruel	11 a.m.	5 p.m.	1 a.m.	11 a.m.	6 p.m.	11 a.m.

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CAN *PAULOWNIA* BE A WONDER TREE FOR KARNATAKA ?

RITU KAKKAR, I.F.S.*

ABSTRACT

This paper describes the tree *Paulownia,* which is doing very well in China, but its performance in India is very varied. The success of the species in the usual field conditions is low, though it does well in cool moist slopy places where the soil is fertile and water table is deep. This paper is to caution the farmers from taking up *Paulownia* cultivation on a large scale under conditions not suitable to this species.

Introduction

Paulownia, Sieb. and Zucc., a native of China has seventeen species (Willis, 1973) of which *P. albiphloea, P. australis, P. catalpifolia, P. elongata, P. fortunei, P. fargesii, P. kawakamii, P. taiwaniana* and *P. tomentosa* are common. In its place of origin it displays amazing properties due to which it is extremely popular and known as a marvelous tree species. It is said to exhibit characteristics of fast growth, good wood quality, multiple uses, wide ranged distribution, deep root system etc. But, is this tree suitable to South Indian conditions?

Various organizations in India are projecting *Paulownia* as a fast growing species which integrates well with wheat, maize, rape seed, cowpeas, vegetables and many other agricultural crops. Not only this, its use in China for air craft and ship building, partition boards, furniture and cupboards, ceiling and inner roofs, musical instruments, handicrafts, toys, packing cases, etc., is being highly publicized. At this stage, it is absolutely necessary to caution the farmers that this type of publicity is an absolute exaggeration and *Paulownia* is not a species which should be readily adopted as an agro forestry species by farmers. A lot of research and deep study is required before this species should be taken up on a large scale in Karnataka.

The species and its distributions

The genus *Paulownia Sieb.* and *Zucc.* belongs to family *scrophulariaceae.* Some taxonomists include this under *Paulowniaceae* (Willis, 1973). The *Paulownia* species that occur in the areas north to the Yangtze River are *Paulownia elongata, P. catalpifolia* and *P. tomentosa,* among which *P. elongata* grows faster and is suitable for intercropping with crops, while the other two species grow slower but have better wood quality. The species of *Paulownia* that occur in the areas south to the Yangtze River (subtropical zone) are *P. fortunei, P. australis, P. albiphloea, P. fargesii, P. kawakamii* and *P. taiwaniana,* among which *P. fortunei* has the characters of fast growing and straight stem, *P. kawakamii* grows slower with a poor stem form and *P. fargesii* can grow at the sites with elevation of 1,200 – 2,000 meters.

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Utilization

The naturally grown wood of *Paulownia fortunei* is used for a variety of purposes in China such as air craft and ship building, partition boards, house construction, furniture and cupboards, ceiling and inner roofs, musical instruments, handicrafts, toys, packing cases, paper and pulp, etc.

Paulownia is also known for its medicinal properties. Medicines made from *Paulownia* leaves, fruits and wood have certain effects on bronchitis especially in relieving the cough and reducing phlegm. The leaves of *P. tomentosa* contain ursolic acid, $C_{30}H_{47}O_3$ and matteucino, $C_{18}H_{18}O_5$. Its Xylem contains *Paulownian,* $C_{20}H_{18}O_7$ @ CH_3OH and d – sesamin. From its bark, syringin, $C_{17}H_{24}O_9$ @ H_2O and catalpinoside were isolated. Its fruits contain acid, fatty oil, flavanone and alkaloid. A solution prepared from the leaves and fruit dissolved in water, when applied daily to the scalp, is said to promote healthy hair growth and turn hair from gray to black. Another solution, using the leaves and wood, relieves swollen feet. Pharmacological experiment shows that fruit extracts can relieve cough and asthma and its fruit can reduce blood pressure.

The large and hairy leaves of *Paulownia* play a very useful role in purifying dust and smoke. *Paulownia* has become the main tree species for afforestation in Chengdou, Szechuan province, because dust and smoke pollution are comparatively serious there. *Paulownia,* in China grows normally in the polluted districts whereas many other trees drop their leaves or fail to grow at all under the same conditions.

The leaves and flowers of *Paulownia* are good fodder for pigs, sheep and rabbits. The flower buds, flowers and the leaves of *Paulownia* contain fat, sugar and protein. The nitrogen content in *Paulownia* leaves can be compared favorably with some leguminous plants. People in Kwangsi make green manure with *Paulownia* leaves which is an excellent manure.

In India, the plantation grown material is being tried for various end uses and also tested for different processing techniques at Forest Research Institute, Dehra Dun. It has been suggested for pencil making, decorative uses, paneling, cupboards, chest of drawers, toys, handicrafts, etc. (Shukla *et al.*, 1997). However, in India, preliminary studies on strength of 2 year old tree material has revealed it to be a weak timber (Shukla *et al.,* 1997). Even though studies carried out on 2 to 3 years old material has confirmed its suitability for wood based panels like plywood, block board etc. (Shukla and Negi, 1997), its durability is not known and may require treatment with preservatives.

Paulownia in the field

In China, this species is being grown for centuries in the lower parts of mountains. In India, *Paulownia* has been tried in Himachal Pradesh, Rajasthan, Haryana, West Bengal, Arunachal Pradesh and Uttaraanchal on experimental basis. Though it is doing well in some places, in general it is observed that :

1. *P. fortunei* is doing better than other species of this genus but all species of *Paulownia* show damages on their trunks due to heat. Also, when, compared to other trees, *Paulownia* seems to be prone to more number of diseases and insect infections (Dhiman R.C.). The common diseases in

Paulownia are Damping-off, Foliar diseases, Root and basal rot, Root knot nematodes etc.

2. Some people are publicizing *Paulownia* as the fastest growing species. This is not true. Poplar is definitely a faster growing species than *Paulownia*. In the nursery *Paulownia* may grow very fast, but once planted in the field its growth rate reduces tremendously (Dhiman R.C.).

3. *Paulownia* is suitable for cool, moist slopy places (where water logging can not take place) and where the soil is very fertile and water table is deep. In India, this would be suitable in tea gardens and slopy places in the hills. In China also this species is being grown in tea gardens on a large scale (Dhiman R.C.).

4. If water table is high or the area is water logged *Paulownia* does not do well. *Paulownia* can not grow in places with clayey, dry or poor soil, too strong wind, light saline or alkaline soil, bad drainage, excessively high water table (less than 1.5m deep) and extremely low minimum temperature (below – 20°C).

5. In areas where *Paulownia* is grown on experimental basis there is a lot of variability in its growth. In Dehra Dun, in an experimental plantation of 7.5 years, one tree had a circumference of 105 cms. while most other trees had circumference of 40-50 cms. (Dhiman R.C.) It is clear that a lot of research work is still required in this species. By selection we may be able to get a standard variety.

A study conducted on growth of *Paulownia fortunei* in riverbed bouldery land showed that growth and volume of *P. fortunei* was very poor in this area as compared to irrigated and even rainfed agroforestry system but is more than some of the native species (Sri Charan Singh *et al.*, 2003).

Trial of *Paulownia* in and around Bangalore

In the last few years *Paulownia* has been tried in Silviculture division of Karnataka State Forest Department at Channapatna, Kolar, Hoskote, Bangalore, etc. The results are not very encouraging. Not only is the growth slow, the survival percentage is also quite low. In dry season they seem to dry off but when rain comes they recover for some time. In 1988 seeds of *Paulownia* were imported from China and seedlings raised at Hoskote. However, post germination survival was very poor and only 4 seedling survived (Research Report of Silviculturist, C.Z., 1988-89). They were planted in Nallal Nursery in the year 1989 and 3 of these trees are surviving today. The maximum plant height and girth obtained in 14 years is 16m and 180 cms. respectively. Recent plots have not shown any promising results, for example 2 year old plantation at Chickammanagudde Research Station at Chennapatna shows height ranging from 98 cms. to 2.30m and girth ranging from 11.5 cms. to 16 cms. with about 70% survival. The results of planting at Nallal – C block are even more discouraging. 3 year old plants show only 18% survival with plants height ranging from 0.75m to 1.13m. Similarly 2 year plantations at Nallal – C block show height ranging from 1.22m to 1.70m. In Bangalore Range

at Bommanahally 2001-2002 plantations has 0% survival while plantation at Doresanipalya of 2000-2001 has 90% survival and height ranges from 0.95m to 3.6m. *Paulownia* in initial years showed flowering and slow growth in Yeshwanthpura Research Station at Kolar.

On discussions with officials of other Silviculture Divisions of Karnataka, it was found that in Silviculture Division, Madikere, *Paulownia* has not been successful. In Chalkere of Silviculture Division, Bellary, they grew *Paulownia* with drip irrigation. Here, survival is there but some seedlings are branchy and have started flowering.

An attempt was made to find out the farmers experience of this species. Mr. Prem Durai of Tripur was contacted. He said he had planted about 2000 seedlings of *Paulownia* in December 2001. It did very well for 6 months, but after that due to severe wind, leaves fell and it failed. Finally, he had to remove these seedlings and plant teak. He suffered heavy financial loss due to this. Another farmer by the name Subramanyam of Coimbatore District said that he had planted 100 seedlings but it failed.

Conclusion

Paulownia, which is considered to be an exceptionally good tree for farm forestry in China may not prove to be so in all regions of India. *Paulownia* is suitable for cool, moist, slopy places where water logging can not take place and where the soil is fertile and water table is deep. It is prone to a large number of diseases. It exhibits a lot of variability in growth. The field experience of *Paulownia* shows that the rosy picture painted of this species from China, may not be true for all places in South India. Its performance depends on a number of factors and it should not be blindly taken up by farmers till its performance in various regions is properly established.

Chickammanagudde Research Station, Channapatna – A plant from 2001 plantation

Performance of *Paulownia*

Location	Plantation year	Soil Type, Espacement, pitsize	Source of Seedlings	Survival	Height in (m)	Collar Girth in (cm)	Remarks
Nallal Nursery, Hoskote	1989	Red sandy loam	Seeds were brought from China & sown in Hoskote Nursery. Post Germination survival was poor & only four seedlings survived	3 plants out of those four seedlings are surviving 75%	12 mtrs, 13 mtrs, 16 mtrs.	132 cm 98 cm and 180 cms.	Grown under ideal nursery condition
Nallal – C Block, Hoskote	2000	Red sandy loam espacement 3 x 3. Pit size 60 cm^3	TERI New Delhi	18%	0.75 mtrs. to 1.13 mtrs.	7 cm to 10 cm	Growth not satisfactory
Doresanipalya, Bangalore	2000	Red sandy loam espacement 1 x 1. Pit size 60 cm^3	TERI New Delhi	90%	0.95 mtrs. to 3.6 mtrs.	9.5 cm to 38 cm	Grown near the nursery growth is varied.
Nallal – C Block, Hoskote	2001	Red sandy loam espacement 3 x 3. Pit size 60 cm^3	Growmore Bio-Tech, Hosur	52%	1.22 mtrs. to 1.70 mtrs.	9 cms to 14 cm	Growth not satisfactory
Chickamanagudde Research Station, Channapatna	2001	Red sandy loan espacement 3 x 3. Pit size 60 cm^3	Growmore Bio-Tech, Hosur	70%	90 m. to 2.30 m	11.5 cm to 16 cm	Plants seem to dry off in dry season but recoup in rains
Bommanahally, Bangalore	2001	Red sandy loam espacement 3 x 3. Pit size 60 cm^3	TERI New Delhi	0%	–	–	Species not suitable to the area
Yeshwanthpura Nursery Kolar	2001	Red sandy loam espacement 3 x 3. Pit size 60 cm^3	Growmore Bio-Tech. Hosur	99%	Ht. of best 10 trees is from 2.1 m to 3.0 m	Gh. of best 10 trees is from 17 cms to 26 cm	Plants are already flowering

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STATUS OF JOINT FOREST PLANNING AND MANAGEMENT (JFPM) IN KARNATAKA: A DECADE EXPERIENCE

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ABSTRACT

Joint Forest Planning and Management (JFPM) is a decade old programme in Karnataka, brought institutional changes in forest management. It emphasizes on collective and collaborative efforts of Forest Department (FD), local communities and non-government organization for conservation and regeneration of forests. Over decade, 3700 Village Forest Committees have been formed in the state and they are protecting an area about 2.5 lakh hectares. Macro and micro level assessments conducted by covering 10 forest divisions and 476 VFCs in the state, revels that good beginning was made by involving local people in management of degraded forests, and regenerating and conserving resources. Further, it is essential to strengthen participatory process, by enabling them to protect open forest and wasteland available in the village and sustainable management of resources. It is possible by building VFCs as a decentralized body, ensuring participation of all section of people by effective implementation of policies.

Introduction

Forests in India have been managed to maintain bio-diversity and ecological balance of the country and contribute to the national economy by meeting multiple forest resource needs. This has been strengthened through the National Forest Policy of 1988 that emphasizes on conservation of bio-diversity by covering 33% of landmass under vegetation; meet biomass needs of rural people and involve forest development communities in protection and regeneration of forests. As a result, Joint Forest Management (JFM) was implemented to build strong village level institutions, which are involved in planning and implementation of forest development activities and sharing of direct and indirect benefits raised of it.

JFM evolved in India through a resolution issued on 1st June 1990, under the National Forest Policy of 1988, which was a break-through in forest management. It gives high priority to environmental stability and meeting the subsistence requirement of local communities. JFM has recognized the role of people in protecting the forests from the experience of community forestry initiatives in various parts of the country. It emphasizes on collective and collaborative efforts of local communities along with Forest Department and non-

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government organizations for conservation and regeneration of forests. Thus the 1988 Forest Policy and JFM are radically different from the previous forest policies in which people and environment were seen, all too often, as antagonistic (Singh and Khare, 1993).

As of now, 27 states in the country have issued respective state resolution for implementation of JFM. About 63,000 Village Forest Committees (VFCs) have been formed that are protecting about 14 Mha of forest area (RUPFOR, 2002). The JFM envisages promotion of community involvement in regenerating degraded lands through social fencing for protection, empowerment of women and marginal groups in forest management, sharing of direct and indirect benefits from the forests to the communities, focus on management of NTFPs and sustainable harvest of usufructs in joint efforts with the State Forest Department.

Structure of Joint Forest Management and Planning in Karnataka

In Karnataka JFM is referred to as "Joint Forest Planning and Management (JFPM)". The Government of Karnataka passed the JFPM order on 2nd April 1993. The order facilitates the formation of a democratic village level organization called "Village Forest Committee (VFC)" that will take the responsibility of development, management and regeneration of degraded forestland of the village. The basic objective of JFPM is to decrease the damage to forests due to various forms of biotic interference and revive the forest resources by involving the communities living in the villages and adjoining the forests by actively involving them in conservation, planning, protection, regeneration, development and management of degraded forests.

Soon after the adoption of JFPM order on 2nd April 1993, the first VFC was formed on 12th April 1993 at Talagadde village in Ankola taluk of Karwar division. However, the first VFC to sign the MoU with the Forest Department was Kangod of Sirsi taluk on 12th January 1995 in Uttara Kannada district. So far 3767 VFCs have been initiated covering 27 districts in the state that are protecting about 2.5 lakh ha of degraded forest.

Evolution of policies for JFPM

In Karnataka, policy initiatives of JFPM started during 1993 and the resolution was issued in June 1993 to implement the programme. The programme was strengthened under Western Ghats Forestry and Environment Project (WGFEP), funded by Department for International Development (DFID), that was implemented in Canara forest circle during 1992 and the programme was extended to Shimoga forest circle during 1996. Further, during this year, JFPM was implemented in Eastern Plains under Forestry and Environmental Project for Eastern Plains of Karnataka (FEPEP), which was assisted by the Japan Bank for International Cooperation (JBIC). Keeping the JFM guidelines issued by Ministry of Environment and Forests from time to time, and the experience and expectation of JFPM programme in the WGFEP project, an

amendment was issued during 1996 to the JFPM resolution of 1993.

Further, a new JFPM resolution was issued during June 2002 by addressing various issues brought out in the guidelines provided by Ministry of Environment and Forests (MoEF) during 2000 and 2002 to promote and sustain community participation in JFM. The benefit sharing mechanism between community and Forest Department has been revised to ensure better incentive for the community for their involvement in planning, implementation and protection of JFPM area. For instance 90% of the benefits derived from NTFP and 75% share of other forest produces that were created with the help of the VFC will accrue to the community. The major incentive for VFC is, 50% share has been extended from JFPM area which was established before formation of the VFC, but excluding valuable species such as Sandalwood, Rosewood, Teak, Honne (*Pterocarpus marsupium*), Matti (*Terminalia paniculata*) and Nadi (*Lagerstroemia lanceolata*). Another major modification is increasing the participation of general body by allowing all adult members to enrol as members, and women participation in Management Committee (MC) has been increased to 50% of the total strength of the MC.

Institutional support for JFPM

Village Forest Committee is the basic village level institution to plan, execute JFPM programmes and to derive benefits from the JFPM area. The interested local community can form promoter committee to approach FD to initiate VFC in the village to implement JFPM. All eligible members in the village can form General Body by paying a prescribed fee. In order to perform various activities jointly with FD, VFC has to be identified by the respective Deputy Conservator of Forest and registered either under Societies Act or Cooperative Act in order to bring legality to the institution. Further, General Body must constitute a Management Committee, which includes representatives from local community and ex-officio members from Forest Department, Panchayat, development departments and local NGOs, however ex-officio members are not eligible to derive any benefits from the programme.

JFPM: role of external funding

JFPM is a decade old programme in Karnataka. Its implementation has largely been under two major external funding. Initially the programme was largely implemented with support from the DFID assisted WGEFP from 1992-93 to 1999-2000. Under this project, about 539 VFCs were formed to protect and manage 20,835 ha of forest area in Canara and Shimoga forest circles with a total cost of Rs. 110.42 crores. The main objective of the project was to promote the process of institutional changes in KFD, involve local people in decisions on forest planning and management and to minimize the further loss of forest cover and resources. The total plantation raised under project was 56,632 ha, consists of 28,358 ha of enrichment group, 6,025 ha of artisan model and 22,249 ha of plantations for

local needs (KFD, 1999). However, area given for protection under JFPM was 20,835 ha, which accounts for 37% of the area raised under Western Ghats project.

The JBIC assisted FEPEP is being implemented for Eastern Plains of Karnataka, for the period 1996-97 to 2004-05. This project is being implemented in 141 taluks in 23 districts with an outlay of Rs. 598.55 crore. The project targets to cover 1.97 lakh ha of forest, government and institutional lands under 13 different technical models, distribute 21 crore seedlings for planting in private lands, form 3000 VFCs, improve infrastructure facilities, extension and training programmes. So far 3068 VFCs are protecting and managing an area of about 2.32 lakh ha and 18.47 crore seedlings have been distributed (KFD, 2003).

Other than the above two projects, 23 state sector plan schemes and centrally sponsored schemes are also under implementation to develop degraded forestlands. Under this scheme, about 160 VFCs have been formed (Gowda and Gowda, 2001). Thus under various schemes, so far 3767 VFCs have been formed throughout the state covering an area of about 2.5 lakh ha of degraded forests and other Government wastelands (GoK, 2002).

EERN studies on JFPM

Ecology and Economics Research Network (EERN) under the National Support Group has conducted studies to understand status, functioning and impact of JFM programme in six states in India i.e., Andhra Pradesh, Gujarat, Karnataka, Rajasthan, Tripura and West Bengal. The broad goals of the network are to assess the status, performance and impact of JFM. In this paper, the findings of macro and micro level assessment of JFPM in Karnataka with regard to institutional issues has been addressed to understand the decade experience of JFPM in the state.

Methodology

A macro level assessment of JFPM was conducted based on secondary data collected from Forest Department and literature published. Further, a micro level studies have been conducted in 10 forest divisions to understand the institutional aspects of JFPM and community participation in VFC. Under Western Ghats Forestry Project, 4 forest divisions namely Haliyal, Honnavar and Sirsi falling under Canara Forest Circle and Sagara division under Shimoga forest circle were selected. In Eastern Plains under the JBIC project, 6 divisions namely Belgaum and Gokak falling under Belgaum Forest Circle, Bidar under Gulburga Forest Circle, Gadag under Dharwad Forest Circle, Hassan and Tumkur under Hassan Circle were visited to understand the JFPM in eastern plains. From project area of WGFP and JBIC project, 200 and 276 VFCs were sampled accounting for 40% and 10% of the total VFCs formed in the respective projects. In total 476 VFCs were sampled covering both territorial and social forestry divisions

accounting for 6.55% of the VFCs formed in the state and 45% of the VFCs formed in the divisions selected for the study.

Results

In this section, the pattern of VFC formation at macro and micro level are discussed. The macro-level assessment includes number of VFCs formed and their status, area covered under JFPM, and potential area for implementing JFPM in terms of open forest and wasteland available. The micro level assessment, in selected divisions, assesses the composition of VFCs, community participation and structure of General Body and Management Committee to understand the functioning of JFPM in the state.

Macro level assessment of JFPM

Over the decade, 3,700 VFCs have been formed in the state at an average of 370 VFCs per year. Since the target for formation of VFCs and the area to be brought under JFPM is at the state level, there is no uniform spread of JFPM among the various forest circles. Under the Eastern Plain project, the total number of VFCs initiated is 3068 (at the end of March 2003), thus achieving the set target for the project for the period between 1996-2002. Highest number of VFCs was formed in Bangalore forest circle, which includes three territorial and social forestry divisions i.e., Bangalore Urban, Bangalore Rural and Kolar. Further among divisions, in Kolar territorial division, 165 VFCs have been formed, thus achieving 100% target and in Kolar Social Forestry division, 190 VFCs have been formed against a target of 176 VFCs. It indicates that the spread of VFCs in various forest circles and divisions even at forest ranges is not uniform. The target achieved for formation of VFCs against the set target ranged from 128% in Shimoga forest circle to 75% in Dharwad forest circle (**Table 1**). In Bangalore forest circle, 590 VFCs have been formed against just 28 VFCs in Chamarajanagar forest circle (**Table 1**).

Interestingly, the number of VFCs formed in forest circles, where full to part forest area falls under Western Ghats are 1254, accounting for 45% of the total VFCs formed in Eastern Plain project, in addition to 539 VFCs formed under Western Ghats project. Thus the total number of VFCs formed under the Western Ghats belt accounts for 51% of the VFCs formed in the state. However, Western Ghats project was implemented only in two forest circles i.e. Canara and Shimoga. Shimoga circle is covered under both the projects and 190 VFCs have been formed under Western Ghats project and 58 VFCs under Eastern Plain project. Almost equal number of VFCs have been formed in both forested and dry region, though drier districts are more potential in terms of availability of open forest and wasteland to initiate more number of VFCs to regenerate degraded lands (Rao *et al.*, 2002).

Formation of VFCs followed by signing of MoU between the VFC and FD and microplan preparation are key activities of JFPM at the village level. Signing of MoU gives formal recognition to JFPM programme and enables the community to

involve in planning and executing JFPM activities of protection and regeneration of JFPM area and derive benefits for their involvement. Of the VFCs formed in the state, only 59% of VFCs have signed MoU till end of March 2002. Further 70% of the VFCs in Western Ghats project and 61% of the VFCs in Eastern Plain project have signed MoU with Forest Department to initiate JFPM programmes, in which either plantation raised under various schemes or natural forest or both have been assigned for joint protection and management. In Chamarajanagar circle all 28 VFCs have signed MoU against 45% of the VFCs in Belgaum and Hassan forest circle, that has maximum number of VFCs accounting for 14% and 17% of the VFCs formed under Eastern Plain project in the state respectively (**Table 1**).

In order to protect, develop and manage the JFPM area, preparation of microplan is essential, so community members are allowed to participate in protection, planning, planting and regeneration of the allocated area along with the FD. Thus microplan is prepared wherein a collaborative plan is prepared by the local community and the FD for management, development and protection, including soil and water conservation measures and wildlife preservation etc. for the degraded forest areas and Government waste lands allocated to the JFPM scheme. Microplan also includes assessing the resources availability in the village, current demand and supply of such resources and five-year planning of regeneration and management of resources in the VFC jurisdiction. The Microplan acts as a guiding source for all JFPM activities to be implemented at a VFC. In the state, 63% of the VFCs have prepared microplans that includes 78% of VFCs in Western Ghats project and 64% of the VFCs in Eastern Plain project. Further, within Eastern Plains project, the number of VFCs prepared microplan among various forest circles varies from cent percent in Chamarajanagar to just 45% of the VFCs in Hassan. In Western Ghats project in both circles more than 75% of the VFCs have prepared microplan (**Table 1**).

One of the most prominent activities under JFPM is protection of degraded area by adopting various silvicultural treatments such as regenerating root-stocks naturally, enrichment planting, and afforestation of degraded and waste-lands. There are 13 different regeneration models that have been developed under Eastern Plain project. At the end of March 2002 the area brought under joint protection was 2.53 lakhs ha at the rate of 73 ha per VFC. Further, under Eastern Plain project, the area available per VFC is 83 ha against 39 ha in Western Ghats project. The area per VFC is as high as 412 ha per VFC in Chamarajanagar forest circle followed by 344 ha in Shimoga forest circle under Eastern Plain project and as low as just 15 ha of area covered per VFC in Mysore forest circle. In the Western Ghats project area covering two circles, it is 41 ha in Canara forest circle and 35 ha in Shimoga forest circle (**Table 1**).

It is observed that the area covered under forested districts under the Eastern Plain project is 87,323 ha accounting for 36% of the area covered under the project at an average of 70 ha per VFC. The area covered under drier districts was 1.45 lakh ha accounting for 74% of the project area at a rate of 85 ha per VFC. Under the Western Ghats project, 20,835 ha have been assigned for protection. Thus including both the projects, the forested districts covered under JFPM accounts for 43% of the area covered in the state at a rate of 60 ha per VFC. The forested districts covered are Uttara Kannada, Chickmagalur, Chamarajanagar, Shimoga, Mysore, Hassan and Belgaum. However, potential area available in terms of open forest and wasteland is much higher in drier region (Eastern Plains) than Western Ghats region.

Micro level assessment of JFPM

As can be seen from the previous section, participatory approach to re-generate the wastelands and degraded forests by formation of Village Forest Committees has taken place. The macro level assessment highlights the spread and the status of VFCs formed. VFC is the key institutional intervention to enable local communities to participate in the JFPM process. It is thus important to assess the status of VFCs formed so far with regard to their structure and functioning. Thus this section on micro level assessment of JFPM of Karnataka, the status of the 476 VFCs has been assessed that are located in different forest types to understand the structure, composition, membership pattern of VFCs and functioning of general body and management committees.

Formation and structure of the VFC

The concept of JFPM is that the VFC is a democratically constituted, self-governing and financially viable village body, in which people's involvement is the centre of the activity with the Forest Department playing a supportive role as a partner in this process (KFD, 2001). The most important factor, which determines the functioning of a VFC is the extent of representation of the village community in the process. Maximum representation of the village communities, both men and women, and representation of different ethnic and socio-economic groups is the first step to ensure that it is indeed a democratic body in which the voices of all cross section of the village community is heard.

Membership of adult men and women in the VFC : Membership of VFC by all adult men and women is the critical first step in the JFPM process. In the Western Ghats only 30% of men and 16% of women in the selected villages were members of VFC while it is 13% and 3% in Eastern Plains respectively (**Table 2**). Further among the VFC members, men dominated by accounting for 67% and 97% in Western Ghats and Eastern Plains respectively. It is observed that the pattern of membership to VFCs followed was one household from family as addressed in JFPM resolution

of 1993. However membership patterns addressed in the 1996 amendment (for 1993 JFPM resolution), which specifies one man and woman as enrolled member from family, has not been implemented effectively.

Gender composition of VFCs : The first and foremost for a democratically constituted body is equal gender composition of the VFC. In the study area, the representation of women in the Eastern Plains is 13% and in the Western Ghats region, they constitute 33% of the VFC members. Overall, 75:25 is the gender composition of men to women in the VFCs formed in the state (**Table 2**).

Number of households enrolled as VFC members : Another important indicator of involvement of the local community is the extent of representation of the households (HHs) in a VFC. Further, representation of all ethnic groups in the VFC, especially the marginalized class – the landless, artisans and the SC/ST class is essential for a democratic body. In Karnataka 62% of the total HHs have been represented as members of VFCs in the study area though the representation was better in the Western Ghats compared to the Eastern Plains (**Table 3**). Comparing across the socio-economic groups, the HHs belonging to general category is better represented compared (68%) to the SC/STs, Artisans and Landless groups (50-65%). Across project areas, the representation was better in the Western Ghats compared to the Eastern Plains (**Table 3**).

Constitution of the Managing Committee : The General Body elects a Managing Committee (MC) for a period of 5 years to conduct day-to-day activities of the VFC. These members represent the interests of the VFC members and are responsible for administration and functioning of the VFC. Usually individuals who possess leadership qualities having certain degree of community respect, trust and credibility and are willing to spare time for JFPM activities are expected to be elected to the MC. To ensure that all sections of the village community are represented so that their concerns are heard, it is mandatory that there is representation to women, SC/ST, landless and the artisans of the village. According to the JFPM resolution of 1993 two women members, two SC/ST, one each from landless and artisan, and 4 members from the general category constitute the MC. Apart from the elected members, 4 ex-officio members are part of the MC, who are usually the village accountant, Gram Panchayat Secretary, NGO representative and the Forester/Forest Guard, who is the member secretary of the committee. According to the new JFPM resolution, 2002 a total of ten members should be elected Management committee apart from President, 4 from general category, 2 each from SC/ST, Landless and Artisan out of this 50% will be women members from each representative group.

Number of elected MC members and selection of president : The constitution of MC has been assessed based on the

JFPM resolution of 1993. In the study area, ¾ of the VFCs are according to the stipulated and they have 11 elected members, of which about 7% VFCs have more than the stipulated number. This is due to the fact that the leaders of community have been nominated as members. One fifth of the VFCs have 10 to 8 members, while 4% have less than 8 VFC members.

With regard to representation to different groups, most of the VFCs met the stipulated number of SC/ST, women, landless and artisan members in the VFC committee (76-94%) (**Table 4**). The representation of ex-officio members was very poor both in the Western Ghats and the Eastern Plains region with representation in only 7% of the VFCs. Thus most of the VFCs have been formed according to the JFPM guidelines (**Table 4**).

The registered members of the General Body select the Chairperson or President of the VFC. In the study area, only in 3 VFCs (from Eastern Plains) out of 547 VFCs surveyed have been chosen by election, while the rest of them have been chosen through consensus of all the VFC members. The President of VFCs is usually from the General Category. In Western Ghats, 97% and in the Eastern Plains, 89% of the Presidents are from General Category, the rest being represented by the marginalized groups.

Discussion and conclusion

It is evident from the study that hardly any criterion has been followed while forming VFCs in forest circles/divisions/ ranges. Since the principle objective of JFPM is conservation and regeneration of degraded area, one criterion that can be considered while setting target for formation of VFCs could be extent of open forest and wasteland available. In Karnataka, nearly 14% of geographical area can be brought under the JFPM programme – 4% under open forest and 10% under wasteland category (Rao *et al.,* 2002). So far a total of just 3% of open forest and wasteland together, accounting for less than one percent of geographical area has been covered under JFPM. Considering the open forest area, about 7546 VFCs can be formed. Even considering that all the 3474, VFCs have been formed for this category, another 4,000 VFCs can be potentially formed to regenerate and protect the natural forest at a rate of 100 ha/VFC. Considering only the villages proximal to forests, about 7,130 VFCs can be formed. Considering the existing VFCs that have been formed, the potential still is about 3,600 VFCs. Thus there is still a large potential for degraded area to be brought under JFPM.

Of the 3474 VFCs formed so far in the state, about 95% of the VFCs have been formed under the externally aided projects, while the remaining 5% has been formed under centrally and state sponsored schemes. Hence the programme in Karnataka has been completely driven by external funding. Significant increase in investment through external agencies is supplementing the existing state budget for forestry and has boasted JFPM programme in the state. These projects

have components of stipulations or guidelines for the formation of VFCs, which includes involvement of local communities and NGOs, transparency of functioning, biodiversity conservation components and capacity building programmes both for the FD staff and the community.

But there are still certain concerns, which need to be addressed. Signing of MoU should follow preparation of micro-plan and initiation of various activities in collaboration. It is observed that though meeting these formalities are inadequate to strength participatory process and decentralized management of forest, in some cases VFCs have prepared micro-plan and started functioning without MoU between parties involved in collective work. It lacks legal identity for the efforts made and stake of the community to claim benefits.

Further micro level assessment reveals that, there is lack of implementation of policy at VFCs level. Though several changes have taken place in subsequent resolutions, these have not been reflected at the ground level. For instance, member-ship pattern for VFC was changed to allow all adult member in the VFCs instead of one members from family, in most of the VFCs apart from secretary, who is from forest department, president is not aware of such policy changes happened over a period of time. This results in inadequate participation in general body, which is responsible to elect effective management committee and successful functioning of VFCs. It also results in poor democratic body and leads to centralized decisions taken by certain dominating section of the community in the village. Thus effective implementation of policies is essential along with providing awareness and training to community members.

It is observed in the study area that non-member HHs constitutes about 40%, which is a sizable number. According to the socio-economic structure, in 1/3 of the VFCs sampled, the representation of SC/ ST, LL and Artisans HHs as VFC members constitute less than 75% of the total HHs. Lack of membership not only deprives them access to share of benefits from forest produce, but also excludes them from information and decision making of the VFC, though customarily they have equal rights over the resources of the village. Denial of resource access to non-members could lead to source of conflict, when benefit sharing takes place and also denial of access to non-members could have serious implications with regard to equity issues. From the field, it was noticed that there was no discrimination with regard to access to members and non-members. But this could a potential source of conflict after sizable monetary benefits start accruing to the VFCs. As JFPM imposes new access rules and regulations to the common property resource, which otherwise the community had customary rights, it is essential that non-members are also part of the process. The recognition of role of non-members needs to be addressed.

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Table 1 – Status of JFPM in different Forest Circles, Karnataka

Name of the Forest Circle	No. of VFCs formed#	MoU signed*	Microplan prepared*	Area covered (ha)**
Under FEPEP assisted by JBIC				
Bangalore	590 (95)	396 (67)	442 (75)	26735 (45)
Belgaum	404 (82)	180 (45)	190 (47)	20931 (52)
Bellary	494 (95)	365 (74)	370 (75)	60712 (123)
Chamarajanagar	28 (80)	28 (100)	28 (100)	2013 (72)
Chickmagalur	36 (88)	33 (92)	31 (86)	14846 (412)
Dharwad	216 (75)	126 (58)	126 (58)	35243 (163)
Gulbarga	242 (86)	150 (62)	178 (74)	8545 (35)
Mysore	252 (102)	168 (67)	170 (67)	3829 (150
Hassan	476 (103)	212 (45)	212 (45)	25762 (54)
Shimoga	58 (128)	42 (72)	40 (69)	19942 (344)
Sub Total	**2796 (92)**	**1696 (61)**	**1791 (64)**	**232734 (83)**
Under WGFEP assisted by DFID				
Canara (Uttara Kannada)	349	270 (77)	275 (79)	14176 (41)
Shimoga	190	105 (55)	144 (76)	6659 (35)
Sub Total	**539**	**375 (70)**	**419 (78)**	**20835 (39)**
Under State and Central Schemes	**160**	**NA**	**NA**	**NA**
Grand Total	**3495**	**2071 (59)**	**2210 (63)**	**253569 (73)**

Source : Social Forestry DIvision, Karnataka Forest Department, Bangalore.

Note : Figures for up to end of March 2002, however number of VFCs formed at the end of March 2003 are 3767 in the state.

\# : Figures in brackets indicate percent of VFC formation against the target.

* : Figures in brackets indicate percent of VFCs signed MoU and prepared micro plan.

** : Figures in brackets indicate area per VFC.

Table 2 – Participation of male and female to the total VFC members and to thetotal population in VFCs

Division	Men: Women ratio in the VFCs	% to the total population	
		Men	Women
Eastern Plain	87:13	13	3
Western Ghats	67:33	30	16
Karnataka	**75:25**	**12**	**6**

Table 3 – Percent enrolment of households to VFCs to the total households

Division	General	SC/ST	Artisans	Landless	Total
Eastern Plain	57	46	52	37	**53**
Western Ghats	79	85	78	68	**77**
Karnataka	**68**	**55**	**65**	**50**	**62**

Table 4 – Percent of VFCs formed according to the stipulation of the managing committee structure

State Division	MC committee	SC/ST members	Women members	Landless members	Artisan members	Ex-officials
Eastern Plain	83%	87%	91%	88%	88%	8%
Western Ghats	68%	70%	98%	93%	82%	6%
Karnataka	**76%**	**80%**	**94%**	**90%**	**85%**	**7%**

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WIND – AN UNFAVOURABLE FACTOR FOR TEAK GROWTH

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Teak (*Tectona grandis*) is one of the world's premier hardwood timbers, known for its colour, fine grain and durability. Teak has a wide range of distribution in latitudes between 9° – 25°30'N and longitudes between 73° – 104°30'E. It has been established throughout tropical Asia, as well as in tropical Africa. Teak occurs from sea level to 1200 m elevation and it grows best in localities with annual rainfall of 1000 to 1500 mm, minimum temperature of 13° to 17° C and maximum temperature of 39° to 43° C. The most suitable soil for teak is deep and well-drained deep alluvium with an optimum pH range of 6.5 to 8. Teak produces a tall clean cylindrical bole of more than 25 m under favorable conditions (Troup, 1921; Seth and Yadav, 1959; Kaosaard, 1981 and Tewari, 1992).

As presented in the preceeding paragraph, literature and observations are available to state the favorable range of many important ecological and edaphic factors, like ecological and edaphic factors include latitude, longitude, altitude, mean annual rainfall, minimum and maximum temperature, soil type, soil texture, pH, EC etc. However, little or no observations are reported for teak with respect to favourable range of wind speed.

The present observation on teak grown in farm fields revealed the potential effect of wind factor on teak growth. It also stresses the imperative need to assess the wind influence apart from other site factors before taking up plantation efforts.

The study area is located at Jallipatti, Udmelpet taluk of Coimbatore district (Tamilnadu). The soil was found to be fertile and these lands were being used for cultivation of agricultural crops like groundnut and sorghum. The average yield from these agricultural crops ranged from 800 to 1000 kg/acre for sorghum and 1000-1200 kg/acre for groundnut, which means soil are productive.

Observations were made in two adjacent farm fields wherein teak is being grown under irrigated condition. One field was surrounded with coconut and *Sesbania* trees, which acted as wind barrier and the other field didn't have any such wind barriers **(Plate 1** and **2)**. The data on girth (cm) and height (m) were subjected to statistical analysis through t-test (Panse and Sukhatme, 1961).

The results showed that the mean height in the plantation with wind barrier was about three times of that observed in plantation without wind barriers. Similarly, the girth was also greater (about two times), when the plantation was protected with wind barrier. Further, the co-efficient of variation was greater (almost twice) with respect to both height and girth in the plantation without wind barrier, which in

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turn indicated greater variation in growth under such situation (**Table 1**). This further confirms that both the plantations are different from each other in their growth traits.

The poor growth in the plantation without wind barrier could be directly attributed to the high wind speed prevailing in that locality (between 30 and 35 km/hr) particularly during June to August. During this period, the dry wind with high speed was found to desiccate the young leaves and the apical bud in the leading shoot. Consequently, the wind suppressed both the height and diametrical growth.

Teak does not seem to have any morphological adaptations to heavy and dry wind. On the contrary, height growth of coconut was not found to be affected in this same locality, as the growing tip of coconut was observed to be well protected by the surrounding whirls of leaves.

To conclude, wind factor is to be taken in to consideration along with other important site factors while matching the species – teak with sites for any commercial plantation programme. The present study also stresses imperative need for further investigations to identify favourable range of wind speed for optimum growth of teak.

Table 1 – Mean height (m), mean girth (cm) and co-efficient of variation in two teak plantations at Jallipatti, Coimbatore.

Plantation Descriptions	Age (yr)	Growth Parameters									
		Height (m)					Girth (cm)				
		Min	Max	Mean	S.D.	C.V.%	Min	Max	Mean	S.D.	C.V.%
Plantation without wind barrier	5	1.80	3.50	2.38	0.44	18.44	6.50	15.0	10.16	1.82	17.91
Plantation with wind barrier	5	5.5	8.5	6.75	0.61	9.04	16.5	27.0	22.74	2.34	10.29

Table 2 – Test of significance of means through t-test for growth traits in two teak plantations at Jallipatti, Coimbatore district, Tamilnadu.

	Girth (m)		Height (cm)	
	Teak with wind breaks	Teak without wind breaks	Teak with wind breaks	Teak without wind breaks
Mean	22.71	10.16	6.75	2.38
Variance	5.49	3.30	0.37	0.19
Observations	60	60	60	60
Hypothesized Mean Difference	0		0	
t Stat	32.78		45.33	
P(T<=t) one tail (Probability)	3.24884E-59		5.75693E-72	
t Critical one tail	2.36		2.36	
P(T<=t) two tail (Probability)	6.49768E-59		1.15139E-71	
t Critical two tail	2.62		2.62	

Plate – 1

Teak plantation with wind barrier, Jallipatti, Coimbatore

Plate – 2

Teak plantation with wind barrier, Jallipatti, Coimbatore

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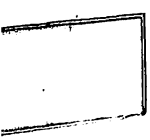

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SOIL FERTILITY STATUS UNDER *SIMAROUBA GLAUCA*

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ABSTRACT

An experiment was carried out to study the effect of *Simarouba glauca* stand on the soil fertility status. Soil samples were collected under a 10 year old plantation of *Simarouba glauca* (male and female stands) and analyzed for the nutrient content including soil reaction (pH) and organic carbon. The results were compared with the analytical results of the soil from a near by barren land which is considered as the control. The soils under trees irrespective of the secs were acidic in reaction in contract to the neutral reaction in the control plots. Under the influence of the tree cover, available nitrogen and potassium were higher and available phosphorus was significantly lower than the control irrespective of the sex. However, the soil samples under the male trees recorded 13 kg/ha of available P at 0-30 cm depth. This was higher than that of the female trees that recorded a lower level of 5 kg/ha of available P. An increase in available K was registered under female trees. Improved soil fertility under *Simarouba glauca* was observed. This result explains the suitability of this species for wasteland afforestation programmes.

Keywords : Nutrient recycling – *Simarouba glauca.*

Introduction

Problems of soil fertility are encountered during the use of plantation forestry owing to the removal of organic matter and nutrients, which takes place during clear felling. The literature regarding the effect of trees on soil fertility however are conflicting. Lundgren (1978) concluded that same fast growing perennials could also cause pronounced depletion of soil fertility and diminution of soil productivity.

In Nigerian alfisols, *Eleais guinensis* was found to decrease soil K (Kowal and Tinker, 1959) and in Ivory Coast, the same species was found to depress Ca, Mg and K with respect to the forest soil (Ollagnier *et al.,* 1978). Positive effect on soil fertility had been established only for a few tree species like *Prosopis cineraria* (Singh and Lal, 1969), *Eucalyptus* spp. (Cozzo, 1976) and *Casuarina equisetifolia* (Venkatachalam *et al.,* 1990).

The Paradise tree (*Simarouba glauca;* Family: Simarubaceae), an exotic introduced from Central America, is a medium sized evergreen tree. The tree is highly drought tolerant and has high economic potential as the seed kernel yields edible oil (50-55%). There is a feeling that oil yielding trees do not enhance soil fertility. These inconsisten-cies underscore the need for additional to resolve the question of the

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effect of tree species on soil fertility. Thus the objective of this study was to investigate the effect of *Simarouba glauca* stand on the soil fertility status and also to find out the effect of male and female trees on soil fertility if any.

Materials and method

The study was conducted in the afforested degraded lands of Forest College and Research Institute, Mettupalayam. The area receives an annual rainfall of 600-800 mm. Soil samples were collected from three different plantations of 10 year old *Simarouba glauca* at two depths *viz.,* 0-30 cm and 30-60 cm at 60 cm away from the tree base. There were four replicates at each depth for male and female trees. Soil samples were also collected in a similar way from a near by barren land, which was treated as control. In total there were 56 samples.

Soil reaction, organic carbon, available nitrogen, phosphorus and potassium were estimated by following the standard procedures (Jackson, 1973). Data were subject to statistical analysis of variance and treatment differences tested for significance after Panse and Sukhatme (1967).

Results and discussion

Soil pH

The soil samples from the control plots registered a neutral reaction, while a significant reduction in soil pH was recorded under the male and female trees of *Simarouba glauca.* With depth, there was a slight increase in pH under the male and female trees. This difference was insignificant. The decrease in pH compared to the control may be attributed to greater decomposition of litter fall contributing to an acidic condition and due to the greater uptake of cationic nutrients by the trees and excretion of H^+ into the soil. A similar lowering 1pH compared to the open land has been reported earlier under *Cassia siamea* (Parthiban and Rai, 1994), *Acacia senegal* (Sharma and Gupta, 1999), *Prosopis cineraria* and *Prosopis juliflora* (FAO, 1981). Nutrification coupled with nitrate leaching also account for lowering of soil pH (Binkley, 1986). This is one of the reasons to grow trees for reclamation of saline and alkaline soils (**Table 1**).

Organic carbon and organic matter content

Organic carbon content and subsequently the organic matter status were higher under *Simaruba* vegetation when compared to the control. A highly significant increase was recorded under both male and female trees. However, the male trees registered a significantly higher organic carbon status of 0.15 and 0.11 per cent at 0-30 cm and 30-60 cm depth respectively (**Table 1**). Under both the sexes of *Simaruba* with increasing depth, there was a progressive reduction of organic carbon, but such variation was not observed in the control sites.

The major avenue for addition of organic matter to the soil from the trees is through litter fall (Brinson *et al.,* 1980). Other than litter, the dead and decaying roots also

contribute subsequently to the organic matter since 20-25 per cent of the total living biomass of trees is resident in the roots (Armson, 1977). The variations in organic carbon and organic matter content within the sex may be due to differences in quantum of the litter fall, stem flow, through fall and chemical composition of the litter. However, this will require further research to augment the current results obtained. With aging, there is possibility of greater production of litter fall as a result of higher rate of production of leafy biomass, hence greater accumulation of organic matter content. The effect of trees in maintaining soil organic matter levels through the supply of litter and root residues is major cause of soil fertility improvement.

Soil nutrients

A higher value of available soil nitrogen was registered under the canopy of *Simarouba glauca* when compared with the control, as observed in other trees. The effect of sex on soil fertility is observed in soils under the female trees registering higher available N content (**Table 1**). Maximum nitrogen level was observes in the upper layers under the soils of female canopy. While, the soils under male trees recorded a high level of available soil nitrogen at 30-60 cm depth. However, this difference at depths between the sexes was statistically non significant. The increased N content associated with the tree species can be attributed to higher rate of nutrient cycling compared to the barren site. The variation in N content with depth in male and female trees may also be attributed to varied rates of uptake of nutrients by male trees from the surface soil over and above the returns of nutrients.

With respect to soil phosphorus, an interesting result was observed. The Olsen's P was 15.40 kg/ha (medium level as per prescribed standards) at 0-30 cm depth while it was too low at 30-60 cm depth in the samples of the control plot. Lower P content was detected under the male tree canopy, with the female trees registering low levels of available P at both the depths. This may be due to increased uptake and less contribution of P by the litters of female trees than the male trees. The variation between male and female trees in P fixation either as Fe or Al phosphates under acidic reaction of the soil may also have contributed to a low level of soil available P under female canopy. This result recessitates a detailed study on the uptake pattern of nutrients by the male and female trees of *Simarouba glauca*.

A reverse trend was observed in the available soil potassium. Results showed an over all significant increase in potassium under *Simarouba glauca* than the control. Though the potassium level in the control plot was appreciable higher, of the male and female trees, an increase in available soil K was observed in the female trees (1240 kg/ha) at 0-30 cm depth. While the male trees registered 615 kg/ha at the surface layers. This 2-4 fold increase in soil potassium may also be contributed to litter input. This is corroborated by a greater concentration of this element in the top soil accompanied by the decline with the depths. Parthiban and Rai (1994) also

reported similar results in other tree species, but such a high rate of available K under female trees is alarming which paves way to analyse the cause. Differences in available K with depths in the control plot were not significant (**Table 1**).

The benefit of trees in soil management is due to their potential to control runoff and erosion, maintain soil organic matter and physical properties and promote nutrient cycling and efficient nutrient use. *Simarouba glauca* is a promising tree with high oil yielding potential. It has all the above qualities and could be an important component of agroforestry. The present study on the nutrient analysis of the soil under the cover of 10 year old *Simarouba glauca* indicates a very good fertility status to support intercropping and promote agroforestry.

As it is exotic tree of recent exposure, sufficient information is not available regarding the nutrient cycling, nutrient uptake pattern and litter decomposition in *Simarouba glauca.* The scientists of this institute have already initiated research on various aspects. However, the current investigation clearly brought into focus that this Paradise tree, when grown in a plantation, has enormous potential to improve the soil fertility status. Hence this tree could be a forerunner among various species recommended for large scale afforestation programmes.

Table 1 – Soil nutrient status under *Simarouba glauca*

Particulars	Nutrient status					
	Depth (cm)	N (kg/ha)	P (kg/ha)	K (kg/ha)	OC (%)	pH
Female	0 – 30	427.0	5.00	1240.0	0.089	5.68
	30 – 60	392.0	6.30	460.0	0.072	5.72
Male	0 – 30	339.0	13.0	615.0	0.147	5.70
	30 – 60	420.0	10.20	490.0	0.107	5.90
Control	0 – 30	238.3	15.40	372.0	0.020	6.97
	30 – 60	210.0	4.50	240.0	0.023	7.01
CD (P = 0.05)		**30.31**	**2.34**	**288.7**	**0.015**	**0.26**

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EFFECT OF ORIENTATION AND SOWING DEPTH ON SEED GERMINATION AND SEEDLING VIGOUR OF NEEM

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ABSTRACT

Neem a versatile medicine cum multipurpose tree offers innumerable benefits to the common mankind. Although it naturally regenerates immediately upon the showers in the ground and finds no problem in emerging, the shape of the seed is often confused in laboratories by the scientists upon its orientation and sowing depth. Keeping this in mind a study was felt upon this line. 4 x 25 neem seeds were sown at three orientations like Micropyle-lateral, Micropyle-down and Micropyle-up at three depths *viz.*, 0.5, 2.5 and 5.0 cm in sand medium under laboratory condition. Thirty days after sowing, the seedlings were evaluated for germination percentage, root length, shoot length, dry matter production and vigour index. Micropyle oriented downwards method proved to be the best orientation method for sowing neem seeds as it registered more of germination (65.25%), maximum root length (13 cm), shoot length (4.8 cm), dry matter production (0.12g/seedling) and vigour (8.41) than that of micropyle lateral and micropyle up orientations. Regarding the depth of sowing 0.5 cm proved to be the best with maximum germination (78.2%) and higher seedling vigour in terms of root length (10.9 cm), shoot length (5 cm), dry matter production (0.118 g/seedling) and vigour index (9.41) than other depths. Thus, this study recommends the micropyle oriented downwards and 0.5 cm sowing in neem.

Introduction

Neem (*Azadirachta indica*) is a versatile tree of the tropics with immense potential to protect the environment while developing sustainable agriculture. Apart from its tolerance to drought and saline conditions, neem can contribute to the income of the rural people through production of seeds. Use of environment friendly neem products for plant protection can avert a major environmental crisis, by avoiding pesticidal residues in food chain. However, very little attention has been taken to popularize the cultivation of neem, although impressive work has been carried out all over the world on its use as a pesticide and germicide, with significant potential for commercialization. Since not much of the knowledge is prevailing among cultivators and farmers in establishing better neem seedlings in the nursery and field, it becomes necessary and essential to probe indepth in to the nursery and cultivation management practices. Hence, the immediate need to explore the possibilities of improving the germination and vigour of

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seedlings was felt and upon this line, the orientation and depth of sowing was assessed for improving the germination of neem seed in the laboratory.

Materials and method

Neem drupes were collected from the plus trees identified at Forest College and Research Institute, Mettupalayam during the normal bearing season (June-July). They were then depulped, washed thoroughly in water and then shade dried to bring the moisture content to a safe limit. Four hundred seeds in four replications of twenty five seeds each were then sown in three different orientations like micropyle-lateral, micropyle-down and micropyle-up and at three depths *viz.,* 0.5, 2.5 and 5 cm in sand medium in the laboratory conditions. Thirty days after sowing, counts were made and the germination expressed as the percentage of seeds which produced normal seedlings (ISTA, 1993). After the germination count, ten random seedlings were measured for their root and shoot lengths. The vigour index (VI) was derived from the formula given by Abdul-Baki and Anderson (1973).

VI = Percentage of germination x seedling length (cm)

Where seedling length is the sum of root and shoot lengths.

After seedling measurements, the seedlings were kept in an oven maintained at 105 ± 1°C for 17 hrs, weighed after cooling in a desiccator and estimated for drymatter production. The data were subjected to analysis of variance and tested for significance (P = 0.05) as per Panse and Sukhatme (1967).

Results and discussion

Among the different seed orientations, sowing of seeds with micropyle oriented downwards performed better, recording more germination (65.2%), longer shoot (4.8 cm), and root (13.0 cm), higher drymatter (0.122 g/seedling) and greater vigour (12.50) (**Table 1**). Similar results were reported by Swaminathan *et al.* (1993) in pungam, while contradictory results were reported by Ponnammal *et al.* (1993) in neem and Pyarelal and Karnataka (1993) in *Quercus.* According to them, horizontal sowing proving to be the best orientation sowing method for those crops. The basic fact behind that better germination associated with the downward orientation of micropyle may therefore be the outcome of greater water likely to be available at a depth slightly away from the soil surface than at soil surface. Dasberg (1971) also states that as the water content increases, the water uptake by seed and its germination was also found to be in the increasing trend.

Regarding the sowing depth at 0.5 cm was found to record more germination (78.2%) and higher seedling vigour interms of root length (10.9 cm), shoot length (5.0 cm), drymatter production (0.118 g/seedling) and vigour index (9.41). With increase in depth of sowing, the viability and vigour of seeds decreased. Sowing at 5 cm depth showed poor performance by registering lower germination (13.1%)

and seedling vigour in terms of root length, shoot length, dry matter production and vigour index (8.8 cm, 2.9 cm, 0.095 g/ seedling and 1.30) respectively. Cooksley (1982) noted higher seedling emergence from about 3 cm sowing depth in *Leucaena leucocephala* while Ponnammal *et al.* (1993) observed better germination at depths from 0.5 to 1.0 cm. In the present study also, sowing of seeds at 0.5 cm depth excelled other sowing depths by recording higher germination and better seedling vigour. Maithani *et al.* (1988) however, reported higher germination in seeds of neem sown at 2.5 cm depth. Seed sowing at 5.0 cm depth drastically reduced the germination and seedling vigour. Iji *et al.* (1993) in *Gliricidia* had reported that germination may fail to occur at greater depth (6-10 cm) probably due to low oxygen tension. Failure to emerge is due to the embryo expanding the food reserve in the seed (cotyledons) in the process of pushing up the heavy layer of soil (Moore, 1943).

Table 1 – Effect of seed orientation and sowing depth on seed germination and seedling vigour in neem

Sowing Depth	Seed orientation	Germination (%)	Shoot length (cm)	Root length (cm)	Dry matter production ($g/seedling^{-1}$)	Vigour index
0.5 cm	Micropyle-lateral	79.3 (62.9)	5.2	10.2	0.112	0.119
	Micropyle-down	89.3 (70.9)	6.5	15.5	0.140	12.50
	Micropyle-up	66.3 (54.5)	3.3	6.9	0.095	6.30
	Mean	78.2 (62.8)	5.0	10.9	0.118	9.41
2.5 cm	Micropyle-lateral	76.0 (60.7)	4.8	12.9	0.116	8.82
	Micropyle-down	85.9 (67.9)	4.8	13.1	0.124	10.65
	Micropyle-up	53.1 (46.8)	3.1	6.3	0.081	4.30
	Mean	71.7 (58.5)	4.2	10.8	0.107	7.90
5.0 cm	Micropyle-lateral	13.4 (21.4)	3.1	10.1	0.100	1.34
	Micropyle-down	20.3 (26.8)	3.2	10.4	0.103	2.09
	Micropyle-up	5.7 (13.8)	2.5	6.0	0.082	0.47
	Mean	13.1 (15.8)	2.9	8.8	0.095	1.30
CD (P = 0.05)						
Depth		1.5	0.42	0.36	0.002	0.34
Orientation		1.5	0.42	0.36	0.002	0.34
Depth x Orientation		2.6	0.73	0.62	0.004	0.58

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WILD-ANIMALS DISTRIBUTION IN KARNATAKA

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Introduction

The 27 Districts of Karnataka geographically fall into two broad categories *viz.*, Western Ghat Districts and Eastern Plains Districts. Normally the distribution of species is distinctive in these two regions. The wild animals found in the Western Ghat Region are different from those found in the Eastern Plains Region, though some animals are common to both the regions. Again many Districts have common animals as they geographically fall in the same category. The following is the District-wise wild-animals distribution in Karnataka, which is shown either in aggregate of Districts or separate for each District as the case may be :

(A) Wild-Animals found in the Western Ghats Region.

Districts	Wild-animals found	Scientific Name
1. Uttara Kannada 2. Dakshina Kannada 3. Udupi 4. Belgaum (Western side Khanapur, Gunji, Hemmadga, Shiroli, Jamboti, Kanakumbi, Chorla, Nagaragali, Tawaragatti, Londa and areas bordering Dandeli) 5. Dharwar, Western and Northern sides (Kalghatgi, Kirwatti, Tadas and areas bordering Haliyal) 6. Hassan, Western and N. W. side 7. Kodagu 8. Mysore, Western side 9. Shimoga, Western side 10. Chickmagalur, Western side 11. Chamarajanagar	1. The Tiger 2. The Panther 3. The Dhole/Indian Wild Dog 4. The Jackal 5. The Leopard Cat 6. The Small Indian Civet 7. The Jungle Cat 8. The Common Plam Civet/ Toddy Cat 9. The Common Mongoose 10. The Striped Hyena 11. The Indian Gian Squirrel 12. The Common Giant Flying Squirrel 13. The Blacknaped Hair 14. The Indian Elephant 15. The Gaur/Indian Bison 16. The Blackbuck/ Indian Antelope 17. The Sambar 18. The Chital.Spotted Deer 19. The Muntjac/Barking Deer 20. The Indian Chevrotain/ Mouse-Deer	1. Panthera tigris tigris 2. Panthera pardus 3. Cuon alpinus 4. Canis aureus 5. Felis bengalensis 6. Viverricula indica 7. Felis chaus 8. Paradoxurus hermaphroditus 9. Herpestes edwardis 10. Hyaena hyaena 11. Ratufa indica 12. Petaurista petaurista 13. Lepus nigricollis nigricollis 14. Elephas maximus 15. Bos gaurus 16. Antilope cervicapra 17. Cervus unicolor 18. Axis axis 19. Muntiacus muntjak 20. Tragulus meminna

(B) Wild-animals found in the Eastern Plains Region.

Districts	Wild-animals found	Scientific Name
CLUSTER I (Common to –) 1. Tumkur 2. Kolar 3. Bangalore Urban 4. Bangalore Rural 5. Mandya 6. Bellary 7. Gulbarga 8. Bidar 9. Chitradurga	1. The Panther (in more wooded areas) 2. The striped Hyena 3. The Indian Fox 4. The Small Indian Civet 5. The Threestripped Palm Squirrel 6. The Indian Porcupine 7. The Blacknaped Hair 8. The Jungle Cat 9. The Common Palm Civet/ Toddy cat 10. The Common Mongoose 11. The Flying Fox 12. The Jackal 13. The Indian Wild Boar 14. The Indian Pangolin 15. The Chital/Spotted Deer (in more wooded areas)	1. Panthera pardus 2. Hyaena hyaena 3. Vulpes bengalensis 4. Viverricula indica 5. Funambulus palmarum 6. Hystrix indica 7. Lepus nigricollis nigricollis 8. Felis chaus 9. Paradoxurus hermaphroditus 10. Herpestes edwardis 11. Pteropus giganteus 12. Canis aureus 13. Sus scrofa 14. Manis crassicaudata 15. Axis Axis
CLUSTER II (Common to –) 1. Tumur (Mydenahalli) 2. Haveri (Ranibennur) 3. Bellary 4. Gulbarga	1. Blackbuck	1. Antilope cercicapra
CLUSTER III (Common to –) 1. Mandya (Melkote) 2. Haveri (Ranibennur) 3. Bellary	1. Wolf	1. Canis lupus
CLUSTER IV (Common to –) 1. Bangalore Urban (migratory) 2. Bangalore Rural (migratory) 3. Mandya (migratory)	1. The Indian Elephant	1. Elephas maximus

CLUSTER V (Common to –)		
1. Bagalkot 2. Bijapur 3. Koppal 4. Davanagere 5. Raichur 6. Gadag 7. Haveri	1. The Wolf 2. The Blackbuck/ Indian Antelope 3. The Small Indian Civet 4. The Threestriped Palm Squirrel 5. The Indian Porcupine 6. The Blacknaped Hair 7. The Jungle Cat 8. The Common Palm Civet/ Toddy Cat 9. The Common Mongoose 10. The Flying Fox 11. The striped Hyena 12. The Jackal 13. The Indian Wild Boar 14. The Indian Pangolin 15. The Indian Fox	1. Canis lupus 2. Antilope cervicapra 3. Viverricula indica 4. Funambulus palmarum 5. Hystrix indica 6. Lepus nigricollis nigricollis 7. Felis chaus 8. Paradoxurus hermaphoroditus 9. Herpestes edwardis 10. Pteropus giganteus 11. Hyaena hyaena 12. Canis aureus 13. Sus scrofa 14. Manis crassicaudata 15. Vulpes bengalensis

(C) Wild-Animals commonly found in both the Regions.

Districts	Wild-animals	Wild-animals
All	1. Jackal 2. Small Indian Civet 3. Common Plam Civet 4. Jungle Cat 5. Common Mongoose 6. Sloth Bear 7. Common Otter 8. The Smooth Indian Otter 9. Flying Fox 10. Threestriped Palm Squirrel 11. Indian Porcupine 12. Blacknaped Hair 13. The Indian Wild Boar 14. The Indian Pangolin 15. The Common Langur 16. The Bonnet Macaque	1. Canis aureus 2. Viverricula indica 3. Paradoxurus hermaphroditus 4. Felis chaus 5. Herpestes edwardis 6. Melursus ursinus 7. Lutra lutra nair 8. Lutra perspicillata 9. Pteropus giganteus 10. Funambulus palmarum 11. Hystrix indica 12. Lepus nigricollis nigricollis 13. Sus scrofa 14. Manis crassicaudata 15. Presbytis entellus 16. Macaca radiata

(D) Some characteristic wild-animals confined to some districts / places.

Wild-animals	Scientific Name	Scientific Name
1. The Wroughton's Free-Tailed Bat (found only at Bhimagad in the entire world)	1. Otomops wroughtoni	1. **Most endangered.** Bhimagad (Barapede caves) in Talewadi in Khanapur Taluk of Belgaum District.
2. Theobald's Tomb Bat (found at Bhimagada, which is the only third place in the entire world)	——	2. – do –
3. The Nilgiri Langur	3. Presbytis johni	3. **Most rate.** Brahmagiri Hills, in Kodagu District.
4. The Liontailed Macaque	4. Macaca silensus	4. **Most rare.** Agumbe, Brahmagiri Hills, Someswara, Sagar, Kudremukh
5. The Chinkara / Indian Gazelle	5. Gazalla gazella	5. Rare. Nagamangala in Mandya District.
6. The Ratel / Honey Badger	6. Mellivora capensis	6. Rare. Kolar (Shidlaghatta and Chintamani)
7. The Wolf	7. Canis lupus	7. Endangered. Melktoe, Ranebennur, Daroji
8. The Ruddy Mongoose	8. Herpestes smithy	8. Rare. Bandipur and Nagarahole
9. The Striped necked Mongoose	9. Herpestes vitticollis	9. Rare. Bandipur, Nagarahole and Uttara Kannada
10. The Fourhorned Antelope / Chowsingha	10. Tetracerus quadricornis	10. Rare. Found in the less densely wooded and hilly forests viz., eastern parts of Bandipur, Nagarahole, Dharwar, Belgaum, Mysore, Shimoga, etc.
11. The Grizzled Giant Squirrel	11. Ratufa macroura	11. Rare. Found at Bandipur.
12. The Black Panther	12. Panthera pardus	12. Rare. Found in semi-evergreen and evergreen forests of Supa, Anshi, Jagalpeth, Yellapur, Sirsi, etc. in U.K.; Shimoga, Jog falls, Agumbe, Varahi, etc. in Shimoga Dist.; Chikmagalur, Kodagu of late seen along Kabini river bank (1998).

Reptiles

Districts	Reptiles	Scientific Name/Location
(i) Snakes		
(A) Western Ghats Forests of :		
1. Uttara Kannada	1. King Cobra or Hamadryad	1. Ophiophagus hannah
2. Dakshina Kannada	2. Common Indian Bronzeback or Tree Snake	2. Dendrelaphis tristis
3. Udupi	3. Golden Tree or Flying Snake	3. Chrysopelea ornata
4. Belgaum (Western side) (Khanapur, Gunji, Hemmadga, Shiroli, Jamboti, Kanakumbi, Chorla, Nagaragali, Tawaragatti, Londa and areas bordering Dandeli)	4. Indian Python	4. Python molurus
	5. Dharmam or Common Ratsnake	5. Ptyas mucosus
5. Dharwar, Western and Northern sides (Kalghatgi, Kirwatti, Tadas and areas bordering Haliyal)	6. Fasciolated Ratsnake or Banded Racer	6. Argyrogena fasciolatus
	7. Checkered Keelback	7. Xenochrophis piscator (Commonest fresh water snake)
6. Hassan, Western and N. W. side	8. Indian Gamma or Catsnake	8. Boiga trigonata (very common in evergreen and decidous forests)
7. Kodagu		
8. Mysore, Western side	9. Indian Cobra	9. Naja Naja
9. Shimoga, Western side	10. Russell's Viper	10. Vipera russelii
10. Chickmagalur, Western side	11. Green or Bamboo Pit Viper	11. Trimeresurus gramincus (a hill forest snake, not seen below 450m)
11. Chamarajanagar	12. Common Green Whip Snake	12. Ahaetulla nasutus

Districts	Reptiles	Scientific Name / Location
(B) Eastern Plains Forests of :		
1. Tumkur	1. Common Wolf Snake	1. Lycodon aulicus
2. Kolar	2. Russell's Earth Boa	2. Eryx conicus
3. Bangalore Urban	3. Indian Python	3. Python molurus
4. Bangalore Rural	4. Trinket Snake	4. Elaphe helena
5. Mandya	5. Dhaman or Common Ratsnake	5. Ptyas mucosus
6. Bellary		
7. Gulbarga	6. Checkered Keelback	6. Xenochrophis piscator (commonest fresh water snake)
8. Bidar		
9. Chitradurga	7. Olivaccous Keelback	7. Atretium schistosum (very common around Bangalore)
10. Haveri		
11. Koppal		
12. Davanagere	8. Common Green Whip Snake	8. Ahaetulla nasutus
13. Raichur		
14. Gadag	9. Common Indian Krait	9. Bungarus caeruleus
15. Bijapur	10. Banded Krait	10. Bungarus caeruleus
16. Bagalkot	11. Indian Cobra	11. Naja naja
	12. Russell's Viper	12. Vipera russelli
	13. Saw-Scaled Viper	13. Echis carinatus (mostly inhabits arid country)
(ii) Crocodile	1. Mugger or Marsh Crocodile	1. Crocodylus palustris Inhabits rivers, lakes, reservoirs and other large bodies of water from the plains upto 600m in the hills. Common in Nugu, Kabini, Kaveri (Ranganathittu), Kalinadi (Dandeli), Tungabhadra rivers and their reservoirs. **Note :** No record of Esturine Crocodile in the State

Districts	Reptiles	Scientific Name / Location
(iii) Fresh water Tortoises or Terrapins (are hard-shelled forms)	1. Indian Pond Terrapin	1. Melanochelys trijuga trijuga (occurs in large river systems)
(iv) Fresh water or Mud Turtles (have a flattened disc like shell covered with soft skin)	1. Peninsular Mud Turtle or Flap-Shell Turtle (Kan. Ame).	1. Lissemys punctata granosa (this widely distributed turtle inhabits pond and tanks, usually an inhabitant of shallow waters and seen basking among aquatic vegetation)
(v) Land Tortoises (shell is heavy and covered with horny shields)	1. Starred Tortoise	1. Geochelone elegans (common in Kolar District, bordering Chittoor Dist. of Andhra Pradesh)
	2. Travancore Tortoise (replaces starred Tortoise in Kodagu)	2. Geochelone travancorica (in the hills between 100-300 m in Kodagu)
(vi) Lizards		
(a) Geckos	1. Bark Gecko	1. Hemidactylus leschenaulti (frequents avenue trees, particularly Banyan and Tamarind, the dark grey colour with wavy bands on the back merging with the colour of the tree bark)
	2. Brook's Gecko	2. Hemidactylus brooki (common. Lives on trees, rocks, under stones and on buildings. Its loud *chuck chuck chuck* call is often heard after dusk)

Districts	Reptiles	Scientific Name / Location
	3. Southern House Gecko	3. Hemidactylus frenatus (a common house gecko seen in houses in S. India)
	4. Termite Hill Gecko	4. Hemidactylus triedrus (a handsomely marked gecko with three white-edged olive-green crossbars on back; greenish above eye. Ground-dwelling form commonly associated with termite hills; widely distributed)
	5. Rock Gecko	5. Hemidactylus maculatus (largest of the Indin Geckos; has dark spots on a grey background; usually associated with rock formations and rock-cut-caves; occasionally on the rough outer walls of buildings and trees).
	6. Banded Rock Gecko	6. Cyrtodactylus dekkanensis (unlike other Geckos, has vertical pupil and the dilations on the toes are absent; had handsomely marked bands on agrey or brown background; usually dwell among rocks and on the forest floor)
	7. Dwarf Gecko	7. Cnemaspis spp. (have slender undilated digits and round pupil; brown above, spotted or marbled with darker colour; ground geckos; partial to rocks in wet, hill forest country; eleven spp. are known in India, all restricted to the forests of the Western Ghats)

Districts	Reptiles	Scientific Name / Location
(b) Agamids	1. Common Garden Lizard or Bloodsucket (Kannada: Otikata)	1. Calotes versicolor (commonest agamid lizard, widely distributed from dry desert to thick forest, from the plains to about 2000 m; an arboreal, diurnal lizard of gardens, hedges, scrub land and forest; usually slides to the back of the bole or branch when noticed; the head, shoulder turn bright scarlet or crimson, hence the name Bloodsucker)
	2. Forest Calotes	2. Calotes rouxi (arboreal; widely distrbuted in the forests of the Western Ghats; comparatively smaller lizard than the above; brown above with patterns; during breeding season the head and a narrow strip along the mid-back of the male turn bright brick-red, contrasting vivid black on the body.
	3. Southern Green Calotes	3. Calotes calotes (a slender, long-tailed, arboreal Calotes; bright grass-green dorsally with whitish transverse stripes on the body; widely distributed in well-wooded forests of the Southern Karnataka, bordering Kerala and Tamilnadu; climbs tall trees.

Districts	Reptiles	Scientific Name / Location
	4. Fan-Throated Lizard	4. Sitana ponticeriana (a small common, ground-dwelling, diurnal lizard, easily distinguished by the presence of only four as against five toes in all other agamids; brown above with darker vertebral spots along the mid back; whitish below; throat fan of the male brilliantly coloured in the breeding season, being blue anteriorly, turning blue-black in the centre and reddish posteriorly. Inhabits all biotopes except the heavy rainfall forests and the deserts; preferred habitat is scrub and sandy country; a fast and graceful runner, occasionally adopting a bipedal gait).
(b) Agamids	5. Draco or Flying Lizard	5. Draco dussumieri (has 'wing membrane' on the flanks between the limbs; coloration cryptic, resembling the bark of the trees on which the lizard lives; ashy-grey or darker above with a median series of black circles; head with a pair of cross bands; ventrally greenish yellow; inhabits primarily evergreen biotopes up to 1000m; also arecanut, coconut and beterl vine plantations in the plans; endemic to south-west India; commonly seen in the semi-evergreen to evergreen forests around Hosanagar-Mookambika road.

Districts	Reptiles	Scientific Name / Location
	6. Peninsular Rock Agma	6. Psammophilus dorsalis (predominantly a rock-dweller from the plains up to 2000m; common on the rocks around Bangalore and Melkote; agile, wary, diurnal lizard; female coloration matches that of the rocks; in the breeding season, the male becomes brilliant crimson red in colour on the head and foreparts of the body, and black elsewhere)
(c) Chameleons	1. Indian Chameleon (Kannada: Hasuronthi)	1. Chamaeleon zeylanicus (a laterally compressed arboreal lizard, with a conical casque on top of the head; eyes large and except for a small aperture for the pupil, covered by the granular, sealed, lidl tongue very extensile and club-shaped at the tip; digits of the hand in two opposed sets, two directed away from and three towards the body; tail prehensile; changes its colour almost instantaneously; basically the colour is green to which patterns of yellow and black are added in the form of bands and spots; occasionally a uniform yellow or grey; the chameleon is arboreal and prefers wooded areas, but uncommon in very heavy rainfall regions; its movements are deliberate and slow; eyes move independently; found on hedges and shrubs in the lesser rainfall Eastern Plains regions).

Districts	Reptiles	Scientific Name / Location
(d) Skinks	1. Common or Brahminy Skink (Kannada: Arani, Havarani)	1. Mabuya carinata (commonest and best known of Indian skinks; shiny brown, olive or bronze above, darker spots often present, flanks darker; a light band from behind the eye to the base of the tail; equally at home in semi-urban and forest areas; primarily a ground dweller
	2. Little Skink	2. Mabuya macularia (common in the forest areas)
	3. Snake Skink	3. Riopa punctata (an elongated, snake-like slender skink with feeble five-toed limbs; brown above, each scale having a basal black spot
(e) Monitor Lizards	1. Common Indian Monitor (Kannada: Uda, Ooodoombu)	1. Varanus bengalensis (widely distributed from evergreen forests to the fringes of the desert; the one I measured at Nagarahole was 1700 mm. in length; common in Madhugiri)

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SUITABLE MULTIPURPOSE TREE SPECIES FOR DRYLAND AND THEIR EFFECT ON SOIL PROPERTIES

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ABSTRACT

A field experiment was conducted to study the performance of multipurpose tree species and their influence on physical and chemical properties of shallow vertisols at Regional Research Station, Bijapur from 1990 to 1998. The research results revealed that *L. leucocephala* recorded higher plant height and MAI than other tree species. *A. Indica* recorded higher (DBH) diameter at breadth height and (MAI) mean annual increment than other tree species. Soil physical properties *viz.*, infiltration rate, pore space and available water holding capacity. Soil physical properties *viz.*, infiltration rate, pore space and available water holding capacity of soil, improved with the plantation. Similarly, soil chemical properties *viz.*, organic carbon and available nutrients increased while pH of the soil decreased with tree planting and was lowest with *L. leucocephala* as compared to other tree species.

Introduction

Multipurpose tree species are very useful in improving the productivity of degraded soils by their better adaptability to harsh atmospheric and poor soil fertility conditions of the dry lands therefore multipurpose tree species could be appropriate option to bring sustainability in the dry land ecosystems.

The fertility of lands in Northern Dry Zone of Karnataka is depleting due to over use or improper management. The cultivation of field crops in these denuded soils has become uneconomical due to hostile environment conditions like low and erratic rainfall, intense solar radiation, high wind velocity and poor fertility status of the soil. Therefore, it is imperative to suggest alternate land use systems for such lands as well as for the fallow lands available in this regions. Tree species in general are known to be more tolerant to adverse soil and climatic conditions and more remunerative than most of the arable crops on long term basis. Hence, it is appropriate to plant multipurpose tree species so as to bring the denuded land under economic cultivation. Studies on the performance of multipurpose tree species and their effect on physical and chemical properties of soil under semi-arid conditions of Northern dry zone of Karnataka are meager. Hence, presence study was conducted shallow vertisols at Regional Research Station, Bijapur (Karnataka).

Materials and method

A field experiment was conducted at Regional Research Station, Bijapur from

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1990 to 1998 on shallow vertisols. The treatments consisted of 12 tree species as detailed in **Table 1**. The experiment was laid out in randomised block design with two replications. Six months old saplings of 12 tree species were planted in each pit measuring 1 cft. A uniform spacing of 2m x 2m was followed irrespective of the tree species. Planting was done on 21 August, 1990. Each treatment (Tree species) was represented by 49 plants and planted in squares (7m x 7m) of which only the middle nine plants were used for observations. At the beginning and the end of the experimentation, soil samples were analysed for their physical and chemical properties following standard procedures. Infiltration rate was measured *in situ* by double ring infiltrometer method. Undisturbed soil cores (dia. 7.5 cm) were collected upto 30 cm depth at 7.5 cm intervals for measuring saturated hydraulic conductivity and bulk density in the laboratory. Water stable aggregates were determined by modified yoder's wet sieving method, pH and electrical conductivity (EC) of the soil were measured in 1:2 soil: water suspension. Soil available P was extracted by the procedure of Olsen *et al.* (1954) and estimated by ascorbic acid procedure. Available K was extracted by 1N NH4 OAC (Merwin and Peech, 1951) and estimated by flame photometer. Available N was estimated by modified Kjeldhal's method (Jackson, 1973). The initial values are presented in Table Observations on plant height, diameter at breast height (DBH) and canopy spread in North-South and East-West directions were recorded every year at the end of each growing season.

Results and discussion

Plant height : At the end of the eight year *L. leucocephala* recorded significantly higher plant height (8.51m) than all other tree species. This was followed by *H. binata* (6.02m). The height of *T. indica* and *P. pinnata* was lowest compared to other tree species. The height of *A. lebbeck, A. indica, C. equisetifolia, D. sissoo, I. dulce, P. juliflora* and *S. saman* did not different significantly. Results are in conformity with the findings of Webb *et al.* (1980). Significantly higher plant height in *L. leucocephala* was attributed to genetic and environmental interaction.

Diameter at Breast Height (DBH) : Significantly higher DBH was noticed in *A. indica* (9.24 cm) than all other tree species diameter at breast height with *S. saman* (8.08 cm) was on per with *L. leucocephala* and *A. lebbeck*. Among the tree species *P. pinnata* recorded the lowest DBH (3.87 cm) than other the species. The results are in agreement with those of Rewai and Patil (1986).

Canopy spread : Canopy spread of all the tree species (**Table 3**) was recorded from 1993 to 1998 in both the directions (North-South and East-West). At the end of experimentation (1998) canopy spread in North-South direction was significantly higher in *S. saman* than in all other tree species. Canopy spread in North-South direction in *P. juliflora* was on par with *A. lebbeck*. A lower canopy spread was observed in *Tamarindus indica*.

In East-West direction, the highest canopy spread was noticed in *A. lebbeck*

followed by *P. juliflora, S. saman.* The lowest canopy spread was with *T. indica* followed by *H. binata.*

Mean Annual Increment (MAI) in plant height : Mean Annual Increment in plant height calculated is given in **Table 5.** Among all the tree species *L. leucocephala* recorded the highest MAI (1.064m) followed by *Hardwickia binata* (0.753m), *A. lebbeck* (0.738m) and *P. dulce, P. pinnata* produced the lowest MAI (0.370m) followed by *C. siamea* (0.406m). It indicated that *L. leucocephala* is faster in growth, while *P. pinnata* and *C. siamea* were slower in annual growth as evidenced by their plant height table.

Mean Annual Increment (MAI) in diameter : The data on MAI calculated on DBH presented in **Table 6** indicates that at the end of 7th year, *A. indica* produced the highest MAI than all the tree species which was followed by *S. saman, A. lebbeck* and *L. leucocephala, P. pinnata* produced the lowest MAI in DBH (0.553m), than all other tree species.

Effect on physical properties : *Pore space :* The soils where *L. leucocephala* was planted shown highest pore space (46.4%) followed by in soils of *A. lebbeck* (45.30%) and *C. siamea* (43.11%). *A. indica* produced the lowest pore space (40.3%), *C. equisetifolia* (40.4%). Higher pore space in the soils planted with *L. leucocephala, A. lebbeck* and *C. siamea* may be attributed to better soil aggregation by addition of large amount of organic carbon and organic acids through the fall of leaf litter to the soil.

Infiltration rate : Infiltration rate of water was higher and almost equal in soils where *L. leucocephala* and *a. lebbeck* were planted (1.31 and 1.30 $ms^{-1} \times 10^5$) followed by *S. saman* planted soil. *T. indica* and *A. indica* planted soils recorded the lowest infiltration rate among all the tree species. They showed that *L. leucocephala* and *A. lebbeck* produced maximum foliage litter which contributed for higher organic carbon content in soils and in turn helped in development of better soil structure in terms of aggregation and pore space. The results are in conformity with the findings of Contractor and Badanur (1996).

Water holding capacity : Water holding capacity of soils differed with different tree species. *L. leucocephala* planted soil showed higher water holding capacity (0.54 kg kg^{-1}) followed by *A. lebbeck* (0.53 kg kg^{-1}) and *S. saman* (0.50 kg kg^{-1} of soil) than with other tree species. Similarly Contractor and Badanur (1996) have also observed improved water retention in soils where different tree species were planted.

Effect on chemical properties of soil : *Soil pH :* Soil pH decreased with planting of different tree species from the initial value. The decrease in pH of the soils planted with *L. leucocephala, A. lebbeck, C. siamea* was noticed (**Table 7**). Decrease in soil pH may be attributed to the release of organic acids during decomposition of leaf residues added to the soil. Similar effect was also noticed by Chavan *et al.* (1995) and Contractor and Badanur (1996).

Organic carbon : Organic carbon content of soils planted with different tree

species increased than initial value. The soils planted with *L. leucocephala, A. lebbeck* and *S. saman* shown higher organic carbon content than soils with other tree species. Soil under *T. indica* recorded the lowest organic carbon content (4.8 g/ kg of soil). The finding are in agreement with those of Hosur and Dasog (1995).

Table 1 – Plant height of different tree species over the years

Sl. No.	Tree species	Plant height							
		1991	1992	1993	1994	1995	1996	1997	1998
1.	*L. leucocephala*	0.60	1.88	3.86	4.35	6.17	7.14	7.95	8.51
2.	*A. lebbeck*	0.35	2.63	3.80	4.35	4.64	4.97	5.33	5.91
3.	*A. indica*	0.32	1.43	2.68	2.95	3.59	3.99	3.95	4.06
4.	*C. equisetifolia*	1.14	1.36	2.04	2.25	2.50	3.01	3.38	4.01
5.	*C. siamea*	0.92	2.25	2.80	2.90	3.10	3.16	3.22	3.25
6.	*D. sissoo*	0.86	2.52	3.05	3.28	3.80	3.93	4.37	4.69
7.	*H. binata*	0.24	2.25	3.40	3.38	4.44	4.85	5.57	6.02
8.	*I. dulce*	0.87	2.13	3.27	3.65	4.07	4.08	4.81	4.94
9.	*P. pinnata*	0.27	1.44	1.97	2.20	2.62	2.62	2.91	2.96
10.	*P. juliflora*	0.72	2.35	2.38	2.45	3.02	3.95	4.43	4.75
11.	*S. saman*	0.66	2.01	2.94	3.20	3.97	4.24	4.26	4.56
12.	*T. indica*	0.53	0.98	1.73	1.85	2.37	2.56	2.70	2.96
	SE±	0.22	0.28	0.12	0.19	0.22	0.24	0.26	2.29
	CD at 5%	0.29	0.81	0.34	0.55	0.65	0.68	0.76	0.85

Table 2 – Diameter at breast height (DBH) of diameter tree species over the years.

Sl. No.	Tree species	Diameter at breast height						
		1992	1993	1994	1995	1996	1997	1998
1.	*L. leucocephala*	2.24	2.73	4.73	5.55	5.98	7.05	7.12
2.	*A. lebbeck*	4.30	4.59	5.84	7.25	7.56	7.86	7.92
3.	*A. indica*	2.05	2.61	4.65	4.85	5.26	7.88	9.24
4.	*C. equisetifolia*	1.34	1.75	1.93	2.50	3.08	4.10	5.24
5.	*C. siamea*	3.18	3.25	3.38	3.50	3.86	4.50	5.04
6.	*D. sissoo*	3.01	3.28	3.95	4.25	4.42	4.89	5.20
7.	*H. binata*	2.47	3.35	4.55	5.10	6.04	6.61	6.87
8.	*I. dulce*	2.44	3.23	4.33	4.90	4.95	5.85	5.97
9.	*P. pinnata*	1.88	2.28	2.55	2.55	3.07	3.31	3.87
10.	*P. juliflora*	3.08	3.32	3.97	4.85	4.99	5.32	5.43
11.	*S. saman*	2.75	3.34	4.84	5.70	6.12	7.41	8.08
12.	*T. indica*	2.33	2.44	2.55	3.20	3.38	4.38	4.48
	SE±	0.28	0.13	0.22	0.32	0.29	0.36	0.34
	CD at 5%	0.81	0.38	0.64	0.93	0.85	1.06	0.99

Table 3 – Canopy spread (m) in different tree species.

Sl. No.	Tree species	North-South					
		1993	1994	1995	1996	1997	1998
1.	*L. leucocephala*	1.27	1.60	1.77	2.15	2.14	2.16
2.	*A. lebbeck*	1.76	2.20	3.13	3.21	3.32	3.75
3.	*A. indica*	1.00	1.55	1.58	1.80	1.96	2.02
4.	*C. equisetifolia*	1.04	1.95	1.90	2.09	2.29	2.29
5.	*C. siamea*	1.99	2.10	2.17	2.20	2.40	2.69
6.	*D. sissoo*	1.18	1.30	1.55	1.92	1.97	2.05
7.	*H. binata*	1.29	1.30	1.48	1.54	1.83	1.90
8.	*I. dulce*	1.34	2.00	2.10	2.48	2.60	2.65
9.	*P. pinnata*	1.21	1.45	2.20	2.46	2.54	2.69
10.	*P. juliflora*	2.17	3.45	3.50	3.51	3.68	3.81
11.	*S. saman*	1.56	2.25	2.66	3.06	4.65	5.73
12.	*T. indica*	1.38	1.42	1.42	1.66	1.65	1.76
	SE±	0.87	0.18	0.12	0.12	0.15	0.25
	CD at 5%	0.25	0.54	0.36	0.35	0.44	0.72

Table 4 – Canopy spread (m) in different tree species.

Sl. No.	Tree species	East-West					
		1993	1994	1995	1996	1997	1998
1.	*L. leucocephala*	1.25	1.55	1.87	2.40	2.18	2.28
2.	*A. lebbeck*	1.86	2.25	2.95	3.26	3.64	3.97
3.	*A. indica*	1.01	1.65	1.72	1.78	1.81	2.14
4.	*C. equisetifolia*	0.95	1.85	2.02	2.02	2.28	3.29
5.	*C. siamea*	1.80	1.90	2.06	2.02	2.20	2.26
6.	*D. sissoo*	1.17	1.55	1.70	2.06	2.15	2.24
7.	*H. binata*	1.22	1.25	1.42	1.45	1.78	1.94
8.	*I. dulce*	1.43	1.55	2.20	2.28	2.36	2.38
9.	*P. pinnata*	1.01	1.35	2.02	2.14	2.11	2.24
10.	*P. juliflora*	2.38	3.05	3.28	3.51	3.62	3.68
11.	*S. saman*	1.35	2.25	2.68	2.95	2.82	2.87
12.	*T. indica*	1.04	1.15	1.23	1.22	1.64	1.83
	SE±	0.07	0.12	0.12	0.11	0.12	0.18
	CD at 5%	0.20	0.36	0.34	0.34	0.36	0.53

Table 5 – Current and mean annual increment (MAI) in height of different tree species.

Sl. No.	Tree species	Current annual increment (m)								MAI (M)
		1991	1992	1993	1994	1995	1996	1997	1998	
1.	*L. leucocephala*	0.60	1.2	198	0.49	1.82	0.97	0.36	0.58	1.064
2.	*A. lebbeck*	0.35	2.28	1.17	0.55	0.29	0.33	0.36	0.58	0.738
3.	*A. indica*	0.32	1.11	1.25	0.27	0.64	0.18	0.18	0.11	0.508
4.	*C. equisetifolia*	1.14	0.22	0.68	0.21	0.25	0.51	0.37	0.63	0.501
5.	*C. siamea*	0.92	1.33	0.55	0.10	0.20	0.06	0.07	0.03	0.406
6.	*D. sissoo*	0.86	1.66	0.53	0.23	0.52	0.13	0.44	0.32	0.586
7.	*H. binata*	0.24	2.01	1.15	0.08	0.96	0.41	0.72	0.45	0.753
8.	*I. dulce*	0.87	1.26	1.14	0.38	0.42	0.01	0.73	0.13	0.618
9.	*P. pinnata*	0.27	1.17	0.53	0.23	0.42	0.00	0.29	0.05	0.370
10.	*P. juliflora*	0.73	1.62	0.03	0.07	0.57	0.93	0.48	0.32	0.594
11.	*S. saman*	0.66	1.35	0.93	0.26	0.77	1.27	0.02	0.30	0.570
12.	*T. indica*	0.53	0.45	0.75	0.12	0.52	0.19	0.14	0.26	0.370

Table 5 – Current and mean annual increment (MAI) in height of different tree species over the year

Sl. No.	Tree species	Current annual increment (m)							MAI (M)
		1992	1993	1994	1995	1996	1997	1998	
1.	*L. leucocephala*	2.24	0.49	2.00	0.82	0.43	1.07	0.07	1.017
2.	*A. lebbeck*	4.03	0.56	0.25	1.41	0.31	0.30	0.16	1.131
3.	*A. indica*	2.05	0.56	2.04	0.20	0.41	2.62	1.36	1.320
4.	*C. equisetifolia*	1.34	0.41	0.18	0.57	0.58	1.02	1.14	0.749
5.	*C. siamea*	3.18	0.07	0.13	0.12	0.36	0.24	0.94	0.720
6.	*D. sissoo*	3.01	0.27	0.67	0.30	0.17	0.47	0.31	0.743
7.	*H. binata*	2.47	0.88	1.20	0.55	0.94	0.57	0.26	0.981
8.	*I. dulce*	2.44	0.79	1.10	0.57	0.05	0.90	0.12	0.853
9.	*P. pinnata*	1.88	2.28	0.27	0.00	0.52	0.24	0.56	0.553
10.	*P. juliflora*	3.08	0.24	0.57	0.98	0.14	0.33	0.11	0.777
11.	*S. saman*	2.75	0.69	1.50	0.86	0.42	1.29	0.67	1.154
12.	*T. indica*	2.33	0.12	0.10	0.65	0.18	1.00	0.10	0.064

Table 1 – Current and mean annual increment (MAI) in height of different tree species.

Sl. No.	Tree Species	Infiltration rate (ms^{-1} x 10^5)	Water holding capacity (kg kg^{-1})	Pore space (%)	pH	Organic carbon (g kg^{-1})	Available nutrient (kg ha^{-1})		
							N	P_2O_5	K_2O
1.	*L. leucocephala*	1.31	0.54	46.20	8.10	6.9	195	11.2	379
2.	*A. lebbeck*	1.30	0.53	45.30	8.10	6.9	189	10.6	384
3.	*A. indica*	0.74	0.41	40.10	8.20	6.1	155	9.2	375
4.	*C. equisetifolia*	0.76	0.41	40.40	8.30	6.0	172	8.7	380
5.	*C. siamea*	1.12	0.43	43.10	8.10	6.3	178	9.8	366
6.	*D. sissoo*	0.81	0.41	42.30	8.20	5.6	181	9.1	374
7.	*H. binata*	1.04	0.46	41.90	8.20	6.2	181	8.8	342
8.	*I. dulce*	1.02	0.47	42.60	8.30	5.9	171	8.2	341
9.	*P. pinnata*	0.86	0.42	40.60	8.40	5.8	162	8.3	314
10.	*P. juliflora*	1.08	0.45	42.80	8.20	6.5	187	8.9	367
11.	*S. saman*	1.28	0.50	44.70	8.20	6.8	191	11.4	389
12.	*T. indica*	0.55	0.42	40.30	8.50	4.8	128	8.0	296

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INFESTATION STATUS OF *DENDROPHTHOE FALCATA VAR. PUBESCENS* (MISTLETOE) IN DIFFERENT AGED TEAK PLANTATIONS OF UTTARA KANNADA DISTRICT

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ABSTRACT

Teak suffers regularly from insects, pathogens and plant parasites in most of the teak growing areas in the Indian sub-continent. In teak plantations infestation by plant parasites particularly *Dendrophthoe falcata var, pubescens* (mistletoe) is a chronic feature. A survey was conducted in different aged teak plantations of Bhagavathi Range of Haliyal Forest Division, Uttara Kannada district, Karnataka to assess the infestation status of *Dendrophthoe falcata var. pubescens* on teak. A visual scoring was used to assess the infestation of mistletoe. Among four teak plantations surveyed for mistletoe infestation, more infestation (33.42%) was observed in older plantations established in 1950 followed by plantations established in 1956 (26.26%) and 1967 (26.05%) and the least was recorded in plantation of 1961 (24.77%). Severe infestation has reduced the growth, vigour and volume increment of teak plantations.

Keywords : *Dendrophthoe falcata var. pubescens,* mistletoe, *Tectona grandis,* Infestation, parasite.

Introduction

Woody angiospermic parasitic plants, commonly known as mistletoes infest trees through out the world. Mistletoes are hemo-arasitic evergreen shrubs that have dichotomously branching stems, thick persistent leathery leaves. Mistletoes were the earliest parasites of plants recognized by Albertus Magnus around 1200 A.D. (Horsfall and Cowling, 1977). Sometimes, they cause major problems for the horticulturists as well as the foresters. Usually these autotrophic semi-parasitic plants flourish on the trunk, branches or aerial roots of the trees. The parasites make contact witht heir host plants by a complex organ called haustorium (Kuijt and Toth, 1976) and through this organ they draw their nutrients and water from the host plants. In India, several species of mistletoe and their effect has been reported on various forest and fruit trees (Brandis, 1906).

Teak (*Tectona grandis* Linn. f.) is an important world tropical timber species, growing naturally in India, Burma, Thailand, Indonesia and Philippines. It is considered as king of timber species, which has been raised in plantations since 1844. The total area under take in India is about 1.4m ha

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(Pandey, 1983). In Karnataka, teak forests cover an area of 77,900 ha with an annual production of 7,080 m^3 (Kadambi, 1993). The growth of teak is influenced by several factors. In recent days, several pests, diseases and plant parasites are affecting the growth and yield of teak immediately after the establishment of teak plantations.

Dendrophthoe falcata var. pubsescens (mistletoe) is one of the most damaging parasites of teak in plantations, which was noted in Nilambur as early as 1867 by Dr. Cleghorn (Lushington, 1896) and it is commonly known as "Loranthus". *Dendrophthoe falcata* belongs to family Loranthaceae. It is one of the major parasite on teak in Kerala. In some of the plantations in Kerala, more than 80% of the trees are infested with this parasite leading to a heavy loss. Heavy attack of this parasite on young trees have often lead to total failure of plantations in Nilambur. These plantations were clear felled much before they attained rotation age for controlling this parasite (Ranganathan, 1982).

Dendrophthoe falcata var. pubescens attack in teak plantations is a serious problem. It failed to attract the attention of plant pathologists, associated with the Indian forestry. In the past four years attempts have been made to appraise the economic and other losses caused by this parasite (Gnanaharan *et al.,* 1983). The work carried out on the infestation status of *Dendrophthoe falcata van. pubescens* in Karnataka is very less. Hence, the present investigation was undertaken to assess the extent of infestation of *Dendrophthoe falcata var. pubescens* in different aged teak plantations of Bhagavathi Range of Uttara Kannada district.

Materials and method

Survey was conducted in selected differnt aged teak plantations of Bhagavathi, Uttara Kannada district during February-March, 2003. In each plantation 5.0 per cent of the area was covered by laying four sample plots (Quadrants) of 50 x 50 m. Number of mistletoe present on teak trees were considered for assessing mistletoe infestation. In each plot total number of healthy trees (trees with no mistletoe infection) and infested trees i.e., trees infested with one mistletoe (A), trees infested with two mistletoe (B), trees infested with three mistletoe (C), trees infested with four mistletoe (D) and trees infested with more than five (E) were recorded to assess the infestation. The following visual scores were made to assess the mistletoe infestation in different aged teak plantations.

Score	Details
H	Healthy trees (with out mistletoe infestation)
A	Trees infested with only one mistletoe
B	Trees infested with two mistletoe
C	Trees infested with three mistletoe
D	Trees infested with four mistletoe
E	Trees infested with more than five mistletoe

Results and discussion

Survey was conducted in selected different aged teak plantations located in Bhagavathi range, Haliyal Forest Division, Karnataka. The information such as habitat, year of planting, number of trees sampled and percent infestation of mistletoe in different plantations surveyed are presented in **Table 1**. All the plantations surveyed

were found to be infested by mistletoe with a range of 21.37 to 40.87 percent. The average percent infestation of mistletoe for each plantation ranged from 26.05 to 33.42 per cent.

Among the plantations, the youngest and the oldest plantation age was 36 and 53 years. More infestation of mistletoe (33.42%) was recorded in the older plantation, which was established in 1950 and less in the younger plantation (24.77%) established in 1961 (**Table 1**). However, in Kerala teak plantations, more than 80.00 per cent of the trees were infested with this parasite, which lead to heavy loss (Ranganathan, 1982).

Among four plantations studied, maximum infestation (21.74%) was found under class A and minimum (0.00%) under class E (**Table 2**). The data recorded on percentage of infestation by mistletoe under various classes shows that, all the classes were recorded in three plantations, except in third plantation established in 1961. This clearly indicates that mistletoe infestation is severe and 3 to 4 mistletoes are observed more frequently in each teak tree. They cause more damages by drawing nutrients and water from the host plant.

Mistletoe infestation varied within the plantations among different sample plots. Maximum mistletoe infestation for class A was recorded in older plantation (21.74%) and the minimum in young plantation (13.33%). Score classes B, C, D and E was also recorded highest in older plantations (**Table 2**) and lowest in 1956 and 1961 plantations. More healthy trees (with less infestation) were recorded in plantation that was establisyhed in 1961.

Though mistletoe infestation is a serious problem, it has failed to attract the attention of forest pathologists in India. Very little efforts have been made to find out the quantitative and qualitative loss of timber due to attack of this parasite and no attempt has been made to study the factors responsible for its rapid spread. A study conducted during 1980-83 in Kerala reports that there was about 41.64% increment loss in a 12-year plantation, where as, it was about 37.18 per cent in 34 year old plantation and mortality due to parasite was about 27.27 per cent and 1.52 per cent respectively in 12 and 34 year plantations. Physical removal of the parasite during this period increased the growth increment by 38.78 per cent and 7.21 per cent respectively in above plantations (Ghosh *et al.,* 1983). Eradication of the parasite by lopping off the individual infested branches is being practiced by the Kerala Forest Department. Management of the parasite using chemicals was also planned but, due to various economic problems and lack of sophisticated high power or aerial spray technology in India, it was not possible to spray chemicals in plantations. A further detailed study is needed to carryout the infestation status of different aged plantations in different locations of Karnataka to test the correlation between the location and age of the plantation with the infestation of this parasite.

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Table 1 – Percentage infestation of *Dendrophthoe falcata var. pubescens* (mistletoe) in difference aged teak plantations of Uttara Kannada district

Location and Year of Plantation	Total No. of Quadrants	Total No. of sample trees	No. of trees	Mean per cent of infestation
Bhagavathi, 1950	4	470	313	33.42 (29.09 – 40.87)
Bhagavathi, 1956	3	508	375	26.26 (21.37 – 29.17)
Bhagavathi, 1961	4	540	406	24.77 (22.40 – 26.67)
Bhagavathi, 1967	4	489	363	26.05 (22.22 – 32.73)

* Values in parenthesis indicate range of infestation.

Table 2 – Percentage of trees affected by *Dendrophthoe falcata var. pubescens* (mistletoe) under the various score classes.

Sl. No.	Year of planting	Quadrant No.	Total No. of Trees	Percentage of trees affected under the various score class (%)						
				H	A	B	C	D	E	Total
1		I	120	66.67	15.00	7.50	5.83	2.50	2.50	33.33
2		II	110	70.91	13.64	7.27	4.54	1.82	1.82	29.09
3	1950	III	125	69.60	16.00	8.80	3.20	1.60	0.080	30.40
4		IV	115	59.13	21.74	11.30	4.35	2.61	0.87	40.87
									Mean	**33.42**
1		I	132	73.48	15.15	9.09	1.52	0.76	0.00	26.52
2		II	120	70.83	20.83	5.00	1.68	0.83	0.83	29.17
3	1956	III	131	78.63	15.27	4.58	1.52	0.00	0.00	21.37
4		IV	125	72.00	17.60	6.40	2.40	0.80	0.80	28.00
									Mean	**26.26**
1		I	138	74.64	17.39	5.0	1.45	0.72	0.00	25.36
2		II	142	75.26	14.08	9.15	1.41	0.00	0.00	24.64
3	1961	III	125	77.60	16.00	4.80	1.60	0.00	0.00	22.40
4		IV	135	73.33	16.30	7.41	2.22	0.74	0.00	26.67
									Mean	24.77
1		I	135	77.78	13.3	5.93	1.48	0.74	0.74	22.22
2		II	129	75.97	15.50	5.43	2.32	0.78	0.00	24.02
3	1967	III	115	74.78	13.91	8.70	1.74	0.87	0.00	25.22
4		IV	110	67.27	20.91	8.18	1.82	0.91	0.91	32.73
									Mean	**26.05**

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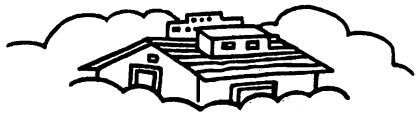

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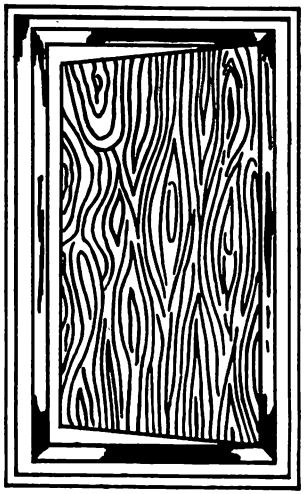

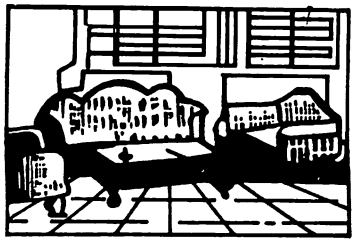

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STANDARDIZATION OF SEED WEIGHT REPLICATIONS OF TREE SPECIES IN ARID AND SEMI-ARID ZONE

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ABSTRACT

Sixteen tree species growing in arid and semi-arid areas of Rajasthan and Gujarat were tested for standardization of their seed weight replications. Among the tested species the maximum variation in 100 seed weight was observed in *Prosopis cineraria, Tecomella undulata* and *Pongamia pinnata* and minimum in *Albizia lebbeck.*

Key words: Seed Weight replication, arid & semi-arid zones, working sample, test weights.

Introduction

Seed weight and size are moderate characteristics of plant species and are dependent on a variety of factors like provenance, genetic makeup and environment where it is growing (Baker, 1972; Cavers and Steel, 1984)). A close relationship between seed size/weight and seed quality has been documented for many tropical hardwoods (Halos, 1983; Gupta *et al.,* 1983; Aquiare and Nakare, 1983; Ponnammal *et al.*, 1993; Negi and Todario, 1997, Wightman *et al.*, 2001).

International Seed Testing Association (ISTA, 1985) has prescribed a minimum of 8 replications for seed weight determination. Perusal of literature showed that the standard replication prescription for various species growing in this region is not documented. The present communication deals with the minimum replications to be taken for determining seed weight of important tree species growing in this region.

Materials and Method

Large quantities of seeds of *Acacia catechu* Willd., *A. nilotica* Linn., *A. senegal* Willd., *A. tortilis* Forsk., *Albizia lebbeck* Linn.. *Azadirachta indica* A. Juss., *Bahiunia veriegata* Lamk., *Cassia fistula* Linn., *Emblica officinalis* Gaertn., *Hardwickia binnata* Roxb., *Leucaena leucocephala* Lamk., *Pongamia pinnata* Linn., *Prosopis cineraria* Macbr., *Prosopis juliflora* Sw. DC., *Tecomella undulata* Seem. and *Tectona grandis* Linn. f. were collected from trees growing in various agro-ecological regions (AERs) of arid and semi-arid areas of Gujarat and Rajasthan. Seeds of each individual tree species were bulked and mixed properly and considered as single working sample. In all 16 tested species 100 seeds were counted randomly from each working sample and test weights were taken and recorded. A total of 30 replications grouped in 5, 10 and 15 replicates of each species were taken and

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recorded. Each group was analyzed statistically for minimum, maximum, range, standard deviation (SD), standard error (SE) and percent variation (**Table 1**).

Results and discussion

Among the species the maximum variation in 100 seed weight was observed in *Prosopis cineraria* (123.58%), *Tecomella undulata* (102.32%) and *Pongamia pinnata* (66.85%). The minimum variation was observed in *Albizia lebbeck* (14.8%), followed by *Acacia tortilis* (15.38%) and *Cassia fistula* (16.01%) (**Table 1**). The observations were recorded for 30 replications.

Table 2 showed the mean value of 100 seed weights, their standard deviations (SD) and coefficient of variations (CV) of various target species grouped in 5, 10 and 15 replications. Among the species the maximum 100 seed weight was for *Pongamia pinnata*. It varied from 70.53g (15 replications) to 80.36g (5 replications). Mean of 100 seed weight *for Tecomella undulata* was minimal and varied from 0.57g (5 replications) to 0.60g in 10 replication set.

Among the species tested, for standardizing the number of replications to be taken as per ISTA rules, *Albizia lebbeck* (CV = 4.03), *Cassia fistula* (CV = 3.87) and *Leucaena leucocephala* (CV = 4.02) requires only five replications (CV $\leq$ 4.0) for estimating seed weight while *for A. tortilis* (CV = 4.50), *A. indica* (CV = 3.53), *Bauhinia variegata* (CV = 4.34) and *Hardwickia binata* (CV = 4.45) require ten replications. Other tested species require fifteen replications to be taken for estimation of 100 seed weight. The species that require only five replications had lesser seed weight variation than other species.

Acknowledgement

The author is thankful to the Director, AFRI for providing facilities.

Table 1 – Mean weight of 100 seeds (gm), standard deviation, standard error, range and percent variation of the seeds in various tree species. The values are from 30 replications of each working sample.

Species	Mean	SE	SD	Range	Min.	Max.	% Variation
Acacia catechu	3.677	0.084	0.327	1.07	3.18	4.25	15.38
A. nilotica	13.865	0.244	0.947	2.92	12.25	15.17	23.84
A. senegal	10.625	0.162	0.626	2.41	9.25	11.66	26.05
A. tortilis	6.983	0.081	0.314	2.83	6.50	7.50	15.39
Albizia lebbeck	10.989	0.144	0.558	1.52	10.25	11.77	14.83
Azadirachta indica	20.734	0.319	1.752	5.88	17.70	23.58	33.22
Bauhnia variegata	28.827	0.323	1.251	4.64	26.56	31.20	17.48
Cassia fistula	17.683	0.183	0.709	2.61	16.30	18.91	16.01
Emblica officinalis	1.935	0.031	0.121	0.440	1.81	2.25	24.31
Hardwickia binata	20.269	0.233	0.902	4.160	18.29	22.45	22.75
Leucaena leucocephala	5.047	0.069	0.265	0.940	4.56	5.50	20.61
Pongamia pinnata	71.733	2.875	11.135	43.52	65.10	108.62	66.85
Prosopis cinneraria	4.078	0.174	0.673	2.83	2.29	5.12	123.58
P. juliflora	2.898	0.055	0.213	0.920	2.58	3.50	35.66
Tecomella undulata	0.591	0.025	0.097	0.397	0.388	0.785	102.32
Tectona grandis	41.271	0.633	2.453	8.7	36.55	45.25	23.80

Table 2 – Seed weight replications of various tree species with their mean values, Standard deviation (SD) and coefficient of variance (CV).

Name of the species	Mean 100 seed weight (g)	SD	CV	Mean 100 seed weight (g)	SD	CV	Mean 100 seed weight (g)	SD	CV
Acacia catechu	3.78	0.46	12.34	3.63	0.25	6.81	3.68	0.16	4.35
A. nilotica	13.74	1.11	8.04	13.86	0.95	6.83	14.11	0.52	3.69
A. senegal	10.28	0.62	6.04	10.62	0.63	5.89	10.80	0.58	5.38
A. tortilis	7.09	0.35	5.06	6.98	0.31	4.50	6.93	0.29	4.24
Albizia lebbeck	10.64	0.42	4.03	10.99	0.56	5.07	11.16	0.55	4.91
Azadirachta indica	19.29	1.16	6.01	19.51	0.69	3.53	19.43	0.72	3.70
Bauhinia variegata	28.79	1.93	6.71	28.83	1.25	4.34	28.84	0.88	3.05
Cassia fistula	17.16	0.66	3.87	17.68	0.71	4.01	17.94	0.60	3.33
Emblica officinalis	1.95	0.10	5.58	1.93	0.13	6.78	1.94	0.09	4.65
Hardwickia binata	20.36	1.53	7.52	20.27	0.90	4.45	20.22	0.46	2.30
Leucaena leucocephala	5.09	0.20	4.02	5.03	0.24	4.78	5.05	0.20	3.96
Pongamia pinnata	80.36	16.47	20.50	74.53	10.60	14.22	70.53	3.95	5.40
Prosopis cineraria	4.21	0.55	13.17	4.01	0.32	7.97	4.08	0.17	4.17
Prosopis juliflora	2.95	0.23	7.85	2.90	0.21	7.34	2.80	0.135	4.84
Tecomella undulata	0.57	0.12	21.01	0.60	0.95	15.91	0.58	0.03	5.32
Tectona grandis	41.53	2.79	6.72	41.27	2.45	5.94	42.94	2.129	4.96

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OBITUARY

B. Natarajan

(06.03.1942 TO 19.08.2003)

Sri B. Natarajan, a Karnataka Cadre Officer of the Indian Forest Service died in Mysore on 19.08.2003 after brief illness. Sri B. Natarajan was a good sportsman during his college days and also during his training period in Indian Forest College. His deep love towards acting prompted him to give stage performance in cultural activities during his training days. He had won many prizes in Forest College as a Sportsman.

Sri B. Natarajan was born on 06.03.1942 in a village called Kunagalli of erstwhile Mysore District (now Chamarajanagar District). After completing his B.Sc. degree from Mysore University, he underwent the professional training in Dehra Dun during 1963-65. He started his career in Karnataka Forest Department as Assistant of DCF in Chamarajanagar Division during April 1965 and he retired as Principal Chief Conservator of Forests in March 2002. During his illustrious 37 years of service he held various posts in Karnataka Forest Department and Forest Corporations. Sri B. Natarajan, as Deputy Conservator of Forests, Bangalore was recipient of Karnataka Rajyothsava award for his meritorious service. He was also recipient of certificate from the Ministry of Environment and Forests in recognition of his meritorious service rendered for the cause of tiger conservation as Conservator of Forests and Field Director, Project Tiger.

Sri B. Natarajan was totally a dedicated forest officer. He was hard working, soft-spoken, kind and humane in his approach. He was known for his simplicity and friendliness.

Sri B. Natarajan leaves behind his wife, two sons, a daughter and grand children besides hosts of friends, colleagues and relatives.

May the departed soul of Sri B. Natarajan, rest in peace.

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VERMICOMPOST AS AN ALTERNATE MEDIA FOR CONTAINER GROWN MACRO PROPAGATED *CASUARINA EQUISETIFOLIA*

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ABSTRACT

A study was conducted to elucidate the effect of vermicompost as a rooting media as it is found to be nutritious and can provide necessary metabolic food reserve for the shoots while rooting. The results reveal the successful use of vermicompost as a media for 100% rooting of *Casuarina* within 20 days without the use of hormones *viz.*, IAA, IBA etc. The nutrient contents were also analyzed and found that a significantly higher percentage of 1.90% N, 0.23% P, 2.45% of K, 2.49% of Ca and 0.36% of Mg were recorded in the seedling grown in a mixture of sand and vermicompost in the ratio of 1:1.

Keywords : *Casuarina,* rooting media, vermicompost, nutrient analysis.

Introduction

Casuarina equisetifolia, native Australia (El. Lahkany and Shepherd, 1983) is cultivated throughout India, mostly as coastal plantations and ornamental avenue tree. It is also being raised as one of the agro forestry component in the country. It is a valuable species for coastal afforestation and sand dune stabilization (Wilson, 1975; Yadav, 1983; Midglay *et al.,* 1983; El. Lakany *et al.,* 1990). Vast stretches of sand along the Coromandel Coast and parts of west coast have been reclaimed for wood production by raising plantations of Casua-rina, under which it is eventually possible to introduce other species. The economic benefit out of this species occupies paramount position in the economic front of Indian sub continent, which yield raw material for various industries (Guha and Madan, 1963 and Guha *et al., 1970).* The tree is short lived, seldom surviving over more than fifty years even under favourable situations and is less favorable localities scarcely reaching an age of twenty five years before becoming hollow (Troup, 1921).

Natural regeneration by seed is scanty or absent in the coastal plantations of India. But in some parts of Karnataka, natural seedlings appear in large quantities in open spaces along the edge of old plantations towards the end of monsoon (Troup, 1921). Vegetative propagation through sprigs and air layering are the common methods in Casuarinas. Vegetative propagation by rooting of sprigs with different rooting hormones has also been attempted earlier (Dabral, 1948; Gurumurthi an Bandari,

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1988; Le Din Ti Kha and Phi Quang Dien, 1992 and Umesh Kanna *et al.*, 2000).

Among the different organics, the one receiving greater attention in the context of organic recycling is vermicompost due to its rich resource of nutrients. The vermicastings contain the beneficial micro flora and the worm cocoons trigger biological activity in the new soil when covered with organic mulch and properly watered. It is estimated that the earthworms can convert 1000 tones of moist organic matter to 300 tonnes of compost. The excreta or casting of earthworms are rich in nutrients (N,P,K, Ca, Mg) and also in bacterial and actinomycetes population. It is estimated that the actinomycetes population in worm casts is over 6 times greater than in the original soil (Gunathilagaraj, 1994). Vermicompost contains other growth regulating substances in addition to major nutrients, all of which are readily absorbed by the crop.

With this background, the present study was initiated to attempt successful rooting with the help of vermicompost as a rooting media without the use of rooting hormones.

Materials and method

This study was conducted in the humidified mist chamber (Relative Humidity 70-90%) of Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu during 2002. Sprigs were prepared from shoot tips to a length of 20 cm from the middle portion of 10 years old trees. Sprigs are nothing but cuttings with cluster of needles on the upper portion which posses the heal of woody tissue with bark intact and basal portion which were more successfully employed to propagate on large scale. The sprigs were planted in different pot mixtures using sand, soil farm yard manure (FYM) and Vermicompost (VC) in different combinations as per following treatment schedule:

T_1. Soil: Sand: FYM @2:1:1
T_2. Soil: Sand: VC@2:1:1
T_3. Soil: Sand @1:1
T_4. Soil: VC @1:1
T_5. Soil: FYM: @1:1
T_6. Sand: VC @1:1
T_7. Sand: FYM @1:1

The various combinations of pot mixtures were filled in 15 x 25 cm polybags. The poly- thene bags were kept in the mist chamber condition and watered twice a day. The experiment was laid in Randomised Block Design (RBD) with five replication. The rooting efficiency was evaluated by observing the following parameters *viz.*, sprouting, rooting, shoot length, root length, collar diameter and no. of nodules. The observations were recorded at 2 months and 3 months after planting (MAP). The needles of 3-month-old springs were analyzed for their nutrient content (Jackson, 1973) Data were statistically analyzed by following the standard procedures of Panse and Sukhatme (1957).

Vermicomposting was taken up at Forest College and Research Institute, Mettupalayam and was prepared from *Simarouba glauca* leaf litter by following the methodology of Sultan Ahmed Ismail (1992). The vermi-compost prepared was analyzed for its nutrient content by following the standard procedures of Jackson (1973). It was found to contain 1.8, 0.72, 0.75 and 36 per cent of total N, P, K and organic

carbon respectively. The CN ratio and PH of the compost was 20 and 6.5 respectively.

Results and discussion

Vegetative propagation

The effect of different potting media on the rooting efficiency of sprigs was significant for all the parameters investigated. All the sprigs rooted successfully. Surprisingly maximum percentage of rooting of sprigs (80.10%) was observed in the pot mixture of sand: VC @1:1 (T_6) followed by the treatments T_2, T_4, T_1, T_5 and T_7. Rooting was also first initiated in this treatment only. Rooting percentage of less than 50 per cent (43.20%) was recorded in the pot mixture of soil: Sand @ 1:1(T_7) and the regular pot mixture (T_1) recorded only 60.50 per cent. The pot mixtures with vermicompost as a component recorded a higher rooting percentage than the other treatments. All the other parameter *viz.*, shoot length, root length, collar diameter and no. of nodules was higher in the pot mixture of sand : VC@ 1:1 (T_6) followed by Soil: Sand:VC @ 2:1:1 (T_2) (**Table 1; Fig. 1**).

It is advisable to propagate *Casuarinas* vegetatively for purpose of selection, genetic improvement to produce quality seedlings for wasteland afforestation. So far, no attempt has been made to use vermicompost as an alternate media for the container-grown macro propagated seedlings. Vermicompost can be prepared very easily at the farm level with minimum resources and at low cost. The vermicomposting will help in better recycling of the unattended tree litters. The results with respect to rooting, seedling growth, formation of nodules and the nutrient content of seedlings clearly indicate the beneficial effect of vermicompost and its growth stimulating property which is similar to any growth promoting hormones such as IAA (Prasad and Kulkarni, 1988; Dhoria and Chandhar, 1990; Chadra and Gandhi, 1995; Gurumurthi et al., 1994); IBA (Ahmed, 1988; Mishra *et al.*, 1994; Shah *et al.*, 1994; Reddy and Venkiah, 1994; Valluari *et al.*, 1995b; Umesh Kanna *et al.*, 2000); NAA (Dhoria and Chadhar, 1990; Mishra *et al.*, 1994; Sharma *et al.*, 1994; Meenu *et al.*, 1997) and 2,4-D phenoxy acetic acid (Gurumurthi and Rawat, 1992).

Nutrient content of Casuarina needles

The nutrient contents were analyzed and found that a significantly higher percentage of 1.90% N, 0.23% P, 2.45% of K, 2.49% of Ca and 0.36% of Mg were recorded in a seedlings grown in the mixture of Sand: VC @ 1:1 (T6). The nutrient content of the needles of the other treatments was of the order T_2, T_3, T_4, T_5, T_3 and T_7. The seedlings grown in the mixture of Sand: FYM @ 1:1 (T_7) and soil: Sand @ 1:1 (T_3) were on par (**Table 2; Fig 2**).

The increase in shoot/root length and nodule number of *Casuarina* was similar to the results obtained in blackgram and cotton to application of vermicompost in combination with different sources of P and PB. This might be because the organic manure (vermicompost) in general increased the concentration of nutrients in plant and in particular the availability of nutrients in soil which would have boosted the rooting

and growth of seedlings (Thiyageshwari, 1995). Vermicompost also has the ability to increase the enzyme activities *viz.*, urease, dehydrogenase and phosphatase (Kalidurai, 1988, Thiyageshwari, 1995). Dehydrogenase activity is an indicator to assess the microbial performance in soil and it reflects the total range of oxidative activities of the soil microflora (Casida *et al.,* 1964). Thus the effect of vermicompost on the rooting and growth of seedlings may be attributed to its role in improving the nutrient availability to the soil and these by the increase in dehydrogense activity. The presence of growth regulating substances in vermicompost in addition to its nutrient contects was also reported by Gunathilagaraj, (1994).

Conclusion

Rooting ability is influenced by genetic component, the physiological state of the cutting and the enviornment in which it is planted. Depletion of metabolic food reserves particularly starch, takes place rapidly during rootin. Alleviation of moisture stress is critical to rooting of cuttings and high humidity is required. Cuttings take up water through the cut base of the shoot. Generally rooting is stimulated by pre-soaking of cuttings in various rooting hormones.

Analysis is under progress to estimate the content of growth regulators in the vermicompost used in the study and nursery experiments are conducted to study the effect of vermicompost on rooting of hard wood and semi hardwood cuttings and the results are awaited. From the present study, it is concluded that a pot mixture of sand: vermicompost @ 1:1 can be used as a media for 100% rooting in *Casuarina equisetifolia.*

Table 1 – Effect of different pot mixtures on rooting, nodulation, and biometrics of *Casuarina equisetifolia* seedlings (2 months and 3 months after sprouting (MAS) (Mean of 5 replicates)

S.No	Treatments	Rootings %	Shoot Length cm	Root Length cm	Collar diameter cm	No.of Nodules	Shoot Length cm	Root Length cm	Collar diameter cm	No.of Nodules
1.	T_1	60.50	12.50	13.40	0.22	5.10	25.10	23.80	0.42	13.40
2.	T_2	62.70	16.20	15.00	0.32	6.40	26.30	20.60	0.32	14.60
3.	T_3	43.20	10.20	6.50	0.25	4.60	20.60	15.70	0.30	9.80
4.	T_4	65.00	14.80	13.40	0.30	6.20	29.10	23.20	0.41	11.60
5.	T_5	58.00	12.20	12.00	0.35	5.30	24.10	19.70	0.32	10.50
6.	T_6	80.10	17.56	24.10	0.40	11.80	34.80	28.30	0.56	24.40
7.	T_7	55.30	10.30	7.00	0.29	5.40	21.50	18.40	0.36	13.20
	SEd	10.75	0.038	0.521	0.052	1.022	1.051	0.544	0.050	1.025
	CD(0.05)	20.150	0.076	1.042	0.104	2.044	2.102	1.098	0.100	2.050

Table 2 – Effect of different pot mixtures on the Nutrient content of 3 months old *Casuarina equisetifolia* sprigs (Mean of 5 replicates)

S.No	Treatment	Total Nutrients (%)				
		N	P	K	Ca	Mg
1.	T_1	0.89	0.18	1.80	1.92	0.19
2.	T_2	1.32	0.15	1.56	1.63	0.25
3.	T_3	0.60	0.10	1.89	1.50	0.10
4.	T_4	1.50	0.13	1.43	1.78	0.26
5.	T_5	0.92	0.11	1.64	1.53	0.28
6.	T_6	1.90	0.23	2.44	2.49	0.36
7.	T_7	0.90	0.11	1.73	1.42	0.23
	SEd	0.09	0.008	0.008	0.020	0.015
	CD (0.05)	0.019	0.017	0.018	0.042	0.031

Fig. 1 – Effect of different pot mixtures on rooting and development of *Casuarina equisefolia* springs (3 mas)

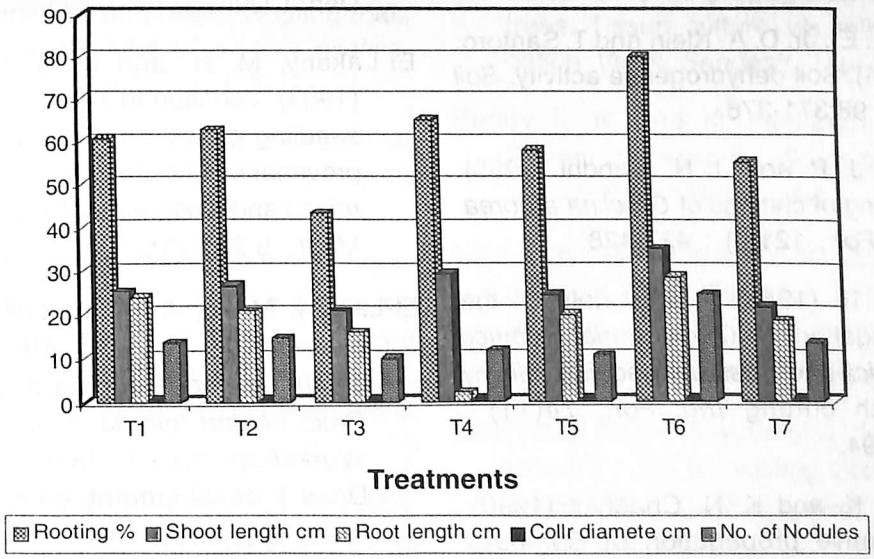
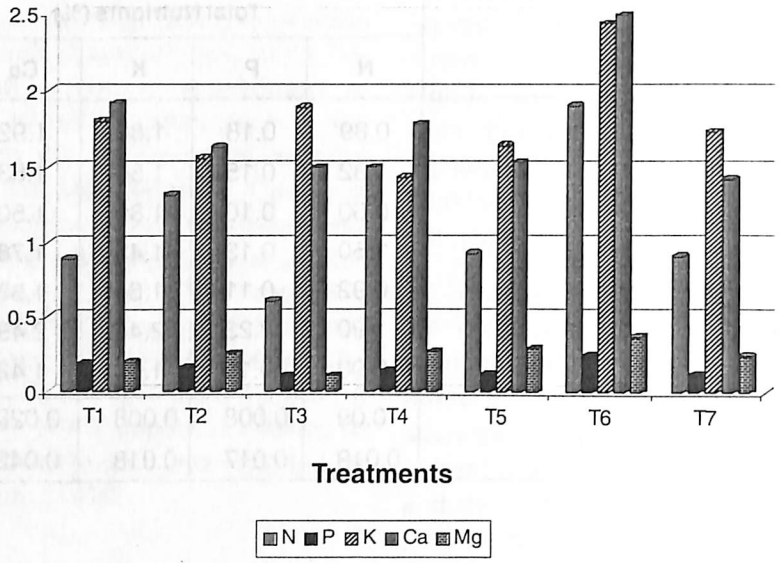


Fig. 2 – Effect of different pot mixtures on the Nutrient content of 3 months old *Casuarina equisetifolia* springs



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VEGETATIVE PROPAGATION OF *AILANTHUS EXCELSA* ROXB THROUGH STEM CUTTINGS

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ABSTRACT

Ailanthus excelsa Roxb is a priority species for fodder in arid and semi arid areas of India. Clonal propagation technique can be very useful for raising quality and uniform plantations as individual trees differ greatly in their growth and foliage density. Present paper deals with rooting experiments conducted with different auxins, in different months, different age donor plants and different material types (branch cuttings, coppice shoots etc.). The time span from February to June was found suitable for shoot sprouting and rooting as well. Stem cuttings of one and two-year-old seedlings were rooted 80 and 24% respectively, when treated with 1000 ppm IBA for 12 hrs. Only middle and bottom portion of 2-year-old seedlings were rooted under the influence of 500-1500 ppm IBA. Maximum 40% rooting was recorded with 1 portion at 1000 ppm IBA. A very low frequency (5.3%) of rooting was observed in stem cuttings prepared from coppice shoots of 8-year-old adult trees.

Keywords: *Ailanthus excelsa,* macropropagation, rooting.

Introduction

Ailanthus excelsa is one of the important tree species for semi arid and arid areas of India. It belongs to family Simaroubaceae and is 18-24m tall large, fast growing deciduous tree. It is generally distributed in India oriental *viz.,* India, Burma, Pakistan, Bangladesh, Malaysia (Roxburgh, 1795). In India it grows commonly in south of the Ganges, in West Bengal, Bihar, Orissa, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan and Haryana. It is also useful for the reclamation of soil and ravines, suitable for stabilization of eroded ravine lands and for shelterbelts and field boundaries in agroforestry (Anonymous, 1990). Being a quick growing species this is suitable for social forestry programme, for cultivation on degraded wastelands, and to check air-pollution.

Ailanthus excelsa is a tree useful in various ways to mankind. The leaves are rated as highly palatable and nutritious fodder for sheep and goats. The leaf protein fractions obtained from *A. excelsa* were nutritionally superior to soybean protein (Nag and Matai, 1994) and said to augment milk production (Singh *et al.,* 1992). The

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leaves of this tree contain 21% crude protein, 2% calcium and excellent balance of essential amino acids. The medicinal and insecticide properties of this tree species have been reported (Atique *et al.,* 1993; Singh and Pandey, 1998; Shastri *et al.,* 1990).

Individual even aged trees differ greatly in their growth and foliage density. Moreover, there are two types of trees, which bear either male or female and hermaphrodite flowers (Roxburgh, 1795). It has also been observed that some trees being only male flowers bearing do not produce seeds (Sharma, 2000). Therefore, clonal propagation technique can be very useful for raising high fodder yielder and uniform plantations. However, non-availability of clonal techniques is the main hurdle for raising quality clonal plantations. Thus the present investigations were undertaken with an objective to standardize clonal propagation method for this tree.

Materials and method

Experiments were conducted with stem cuttings collected from seedlings (1-2 years old) and 5-8 years old trees raised by Arid Forest Research Institute at Dadia, Pali District. Some trees were lopped and few trees were cut from the base during the months of October-December. New sprouts (coppice shoots) produced from the stool portion of tree after 2-3 months. Fresh growths of branches were observed between February and April. Stem cuttings or coppice shoots were collected from such plantation. The thickness and length of cuttings varied from 1.5 cm to 2.5 cm and 12-14 cm respectively. The lower portions of vegetative cuttings were treated with auxins. Upper portions of cutting were covered with choupatia paste (petroleum jelly, red lead and copper sulphate) to prevent fungal attack and desiccation. Cuttings were also treated with liquid fungicides followed by covering the upper portion with wax.

Auxins (IBA, IAA and NAA) solutions were prepared by dissolving them in very small volume of absolute alcohol or 1N NaOH and finally obtaining the desired concentration by adding Milli 'Q' water. Auxin treatment is either given for 12 hours at different levels. In some of the experiments, stem cuttings were treated with Rootex (commercial rooting powder). The cuttings were planted in such a way so that, 2/3rd portion of it remains inside the soil and upper portion bears 2 or 3 buds. A mixture of sand and FYM in 2:1 (v/v) was filled in root trainers (150 cc) or polythene bags. The soil mixture used was sterilized by formalin.

The relative humidity and temperature of mist polyhouse were maintained at 85 ± 5% and 28 ± 5°C respectively. Water was provided through intermittent misting. Misting was provided for 30 seconds after every 5 minutes interval in day (9.00 a m to 9.00 p m) and for 30 second after every 10 minutes in night. Covering the polyhouse with agro net reduced direct sunlight. The

actual light intensity in the polyhouse ranged between 5500 ± 100 lux in winter and 8700 ± 100 lux in summer. The data were recorded upto three months of raising the cuttings.

Results

Initial experiments were conducted with different auxins (IAA, IBA and NAA) with stem cuttings collected from 7-year-old trees. None of these auxins could induce rooting. However IBA was found best for sprouting response followed by NAA. Swelling at the base of stem cuttings were also observed in IBA treatments. Thus further experiments were conducted with IBA only. The results obtained in experiments for selection of best period for raising cuttings, age of source plant, positional cutting in seedling and different material types are as following :

Stem cutting response in a year : The cutting were collected from the branches of 7-year-old trees and treated for 12 hours with varying concentration of IBA (0, 500, 1000, 1500, 2000, 2500 ppm) in every month and kept in mist chamber and data were recorded on rooting and sprouting upto three months. Only shoot sprouting was observed from stem cutting raised during the period from February to June (IBA 0-2500 ppm) irrespective of any treatment used (**Fig. A**). The maximum sprouting, 60% were recorded in the month of May in control. No treatment found suitable for root induction.

Effect of Age : Since all initial experiments with adult trees failed to induce rooting in all the treatment and cutting raised in all the months, it was decided to conduct an experiment on stem cuttings collected from different aged plants with a view to see juvenility phase change in this species. Stem cuttings were prepared from seedlings (1 & 2 years old), and branch cuttings of 5-8 years old tree and treated with 1000 ppm IBA. Stem cuttings could not be incorporated from 3-4 year plants due to non-availability of material. Maximum 80% rooting was achieved from one-year-old seedlings followed by 24% in two-year-old seedlings when treated with 1000 ppm IBA after 30 days (**Table 1**). Stem cuttings collected from 6-8 year old trees could not be rooted in any treatments tried.

Effect of IBA concentration on different portion of seedlings : In another experiment two-year-old seedlings were harvested from mother beds and such saplings were used for preparing cuttings. Stem cuttings were divided into three parts i.e., upper (UP), middle (MP) and basal part (BP). The experiment was conducted in May. Data were analyzed through one-way ANOVA and the results were found highly significant at 1% level. Rooting recorded only in stem cuttings belonging to middle and basal parts at 500, 1000 and 1500 ppm IBA only (**Fig. B & C**). Maximum 40% rooting was recorded in cuttings from middle portion at 1000 ppm IBA. No rooting was observed in upper stem cutting in any of the treatment. Similarly, no portion of

cutting produced roots without IBA and at 2000 ppm IBA (**Table 2**).

Coppice shoots : An experiment was also conducted with different material types. In which stem cuttings were prepared from lateral branches of mature trees, fresh growth of lopped tree and coppice shoots and treated with 1000 ppm IBA, 1000 ppm NAA and Rootex powder. Cuttings prepared from coppice shoots were rooted with very low frequency (5.3%) on 1000 ppm IBA treatment (**Table 3**). Only sprouting was observed from cuttings of lateral branches of mature tree and shoots from lopped tree.

Discussions

Rooting of vegetative cuttings is influenced by several internal and external factors; such as physiological status of cuttings, season of material collection, external environment and growth regulators (Smith and Wareing, 1972). Time period of collecting the cuttings from the mother plant plays a very important role in this process (Nanda and Kochar, 1985; Bhardwaj *et al.,* 1993). In most of the forest tree species, sprouting and rooting occurred in spring, summer and monsoon season. In present studies on stem cuttings of *Ailanthus excelsa,* sprouting commenced from February and was maximum in May. Stem cuttings failed to produced shoots from July onwards and roots in all the months. Similarly, Nautiyal *et al.,* (1992) reported sprouting in *Anogeissus latifolia* from February to July. The same period was found suitable for rooting and sprouting in *Melia azedarach* (Gupta *et al.,* 1989). Gurumurti *et al.,* (1994) observed rooting in *Acacia nilotica* in spring (March) and monsoon (September) season. Rooting in stem cuttings of *Dalbergia sissoo* was reported in February and August (Gupta *et al.,* 1993).

Age of donor tree is the most important factor, which plays an important role in root induction in stem cuttings. Potential of rooting decreases gradually with increasing age of mother plant (Overbeek, 1938). In the present investigation *Ailanthus excelsa* has very high potential of rooting up to one-year-old seedlings, but it sharply decline each year and mature trees more than 6 year old do not root at all. Earlier studies by Nanda *et al.,* (1970) they also categorized this species under very difficult to root species. This kind of correlation of rooting with age of donor tree has been noticed in many woody species (Libby and Hood, 1976; Gupta *et al.,* 1993). However, in some of the wood species like, *Populas deldoides, Dalbergia sissoo,* rooting is possible even with mature tree cuttings (Kamaluddin, *et al.,* 1994; Pain and Roy, 1981; Bulgannawar *et al.,* 1992).

In present study, 2-year-old saplings were divided in three parts; upper, middle and basal. The uppermost cuttings failed to induce root. Whereas, middle and basal portion of stem cuttings rooted in 30 and 28% cases, respectively. Similarly, cuttings belonging to different crown location (upper,

middle and lower) did not produce roots whereas, coppice shoots rooted at low frequency (5.3%). Similarly in *Eucalyptus* hybrid stem cuttings of mature tree (cuttings taken from upper portion of flowering/ flowered tree) failed to root with auxins and successful rooting could be achieved by collecting shoots from coppices of adult tree (Nanda *et al.,* 1968; Gurumurti *et al.,* 1988). Similar effect of position of cuttings were has also been reported in many species *Pinus radiata* (Libby & Hood, 1976), *Tectona grandis* (Nautiyal *et al.,* 1992) and *Dalbergia sissoo* (Ansari *et al.,* 1995). Bonga (1982) suggested that this is because of some juvenile cells/ tissue remain even in mature tissue. In case of tree species, the degree of juvenility is inversely proportional to the distance (along the trunk and branches) between the root shoot junction and branches (Razdan, 1993). Hence the physiologically mature plant juvenile tissue present at root shoot junction produce juvenile coppice shoot. The endogenous auxin levels decrease as the distance from the apices of the branches within the same plant increases (Overbeek, 1938; Jacobs, 1979).

Present studies indicate that adult trees of this species are highly recalcitrant for rooting and very difficult to propagate by vegetative means. However, upto two years old seedlings can be multiplied through cuttings. But at a higher age coppice shoots are the better material for vegetative propagation but further investigations are required for increasing rooting response. In this species standardization of micro-propagation technique is also worth attempting and can be a better alternate than macropropagation.

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Table 1 – Effect of age of donor plant on rooting percentage of *Ailanthus excelsa* stem cuttings. All the cuttings were treated with 1000 ppm IBA for 12 hrs.

Age of Plant	No. of cuttings	Rooting (%)
1 Year	60	80
2 Years	60	33
5-8 Years	60 each	0

Table 2 – Rooting frequency of cuttings prepared from two year old *Ailanthus excelsa* sapling's Upper Part (UP), Middle Part (MP) and Basal Part (BP). Data were recorded after two months of growth in Mist Chambers.

Treatment	No. of Cuttings	Sprouting %	Rooting (%)*
Control	UP 25	0.0	0.0 [a]
	MP 25	40.0	0.0 [a]
	BP 25	24.0	0.0 [a]
500 ppm IBA	UP 25	8.0	0.0 [a]
	MP 25	60.0	24.0 [bc]
	BP 25	20.0	12.0 [ab]
1000 ppm IBA	UP 25	24.0	0.0 [ab]
	MP 25	80.0	40.0 [bc]
	BP 25	80.0	32.0
1500 ppm IBA	UP 25	24.0	0.0 [a]
	MP 25	40.0	28.0 [bc]
	BP 25	40.0	24.0 [bc]
2000 ppm IBA	UP 25	12.0	0.0 [a]
	MP 25	40.0	0.0 [a]
	BP 25	28.0	0.0 [a]

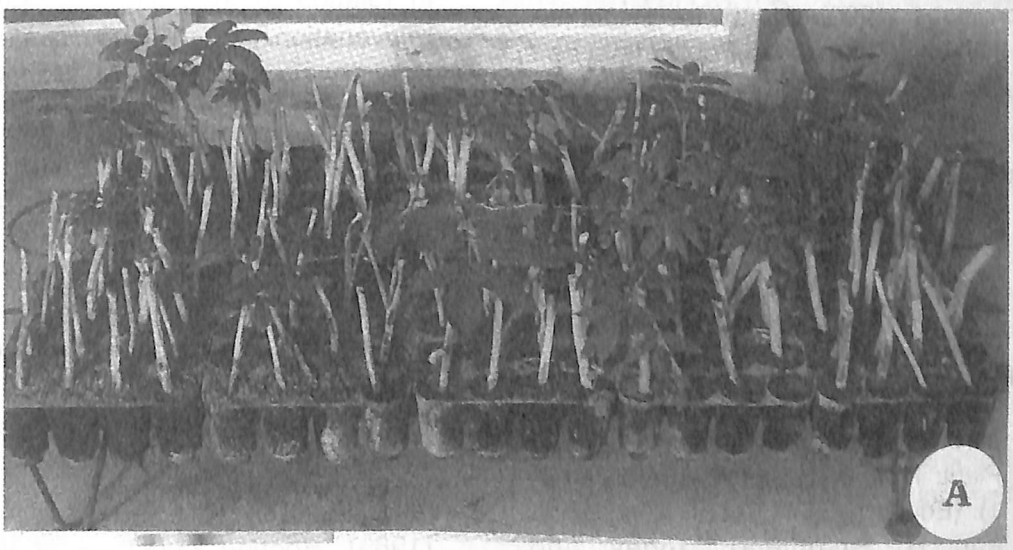
* Any two means having common superscript in the table are not significantly different at 5% level as separated by Duncan Multiple Range Test (DMRT).

ANOVA for rooting response

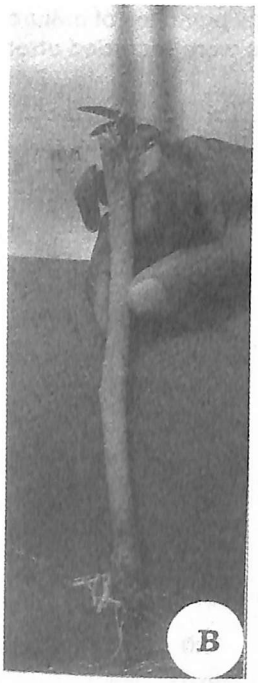
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.493	14	.535	6.823	.000
Within Groups	28.240	360	7.844E-02		
Total	35.733	374			

Table 3 – Rooting and sprouting frequency of cuttings prepared from lateral branches of mature tree (MT), from lopped tree (LT) and coppice shoots (CS). Data were recorded after 7 weeks of raising the cuttings.

Treatment	No. of Cuttings	Sprouting %	Rooting (%)
Control	MT 75	13.3	0.0
	LT 75	15.2	0.0
	CS 60	54.3	0.0
Rootex	MT 75	20.0	0.0
	LT 75	12.0	0.0
	CS 60	44.0	0.0
1000 ppm NAA	MT 75	11.0	0.0
	LT 75	17.0	0.0
	CS 60	53.3	0.0
1000 ppm IBA	MT 75	26.0	0.0
	LT 75	20.0	0.0
	CS 60	38.7	5.3



Sprouting observed in 30 days in *Ailanthus excelsa* cuttings raised from 7-year-old trees in the month of May



Rooting initiation from two-year-old stem cutting (middle portion) treated with 1000 ppm IBA after 30 days.

Roots coming out from the base of root trainer from *Ailanthus excelsa* stem cuttings derived from 2-year-old seedlings after two months of growth

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The Tiger Retires

The only Royal Bengal Tiger, that was roaming up and down, in Aranya Bhavana National Park for more than 35 years, making loud noises often, but roaring occasionally, creating headache to many human beings, has been ultimately captured to retire from August 2003. I was hoping to see and say hello to him once in a way at Bangalore, in Bannerghatta tiger rehabilitation center, created by him only with all fore thought, but I was depressed to hear that he will be tranquilized shortly by his wife for translocation to his original habitat, the Sundarbans area near Kolkata. The original flora and fauna including environment around the Sundarbans have been completely changed now and I really do not know, having cage fed by government so far, how after 35 years, he will be able to hunt with his worn out teeth and bloated physique.

It should not end up with another Public Interest Litigation (PIL) by Tiger and Wildlife Conservationists, or Society for Prevention of Cruelty to Animals (SPCA) or People for the Ethical Treatment for Animals (PETA) to bring him back to Bangalore for better treatment and rehabilitation. I was shocked to hear that anticipating such a move, his original den was also sold out to prevent his come back.

Shri Sachikant Chakrabarti M.Sc. (Geology) of Calcutta University was in Karnataka from day-one of the re-introduction of Indian Forest Service in our country, with three of his illustrious batch mates, Dr. K. A. Kushalappa, Dr. S. N. Rai and Dr. K. N. Baidya, placed in the same order of seniority. He was placed third amongst four in the overall seniority of the state. It is a pity that inspite of all the coaxing, he chose to remain as a "compounder" to three doctors. In fact, the double doctor colleague has offered to transfer one of his prefixes and other two doctor colleagues offered to write thesis for him but he flatly refused, as it was not ethics to his liking and the Universities have no such provision.

I knew him, before he joined Karnataka cadre, at IFC Dehra Dun, as my junior batch mate (1966-67), freshly captured from Tollygung near Sundarbans and sent immediately for his two years field training by West Bengal Government. He had great liking for football and cricket and knew that forestry is not only science but also art and experimented with students while imparting training for 9 long years at Kurseong. He has pleasing manners, friendly and playful as a pet, roars yet lovable, sincere, lion hearted and a hard worker. But I came to know of his satiating appetite for good food, particularly for sweet water fish, only during our probation at Dandeli division and my, then young wife will vouch for it even today. It is no wonder that even today his bulk betrays the truth.

He will be deserting us forcibly and I do hope that his old habitat but the new surrounding environment will bring him joy and his old sweet memories of his boyhood to withstand this separation and to enjoy all his retired life peacefully and happily to hit a century. We, particularly his three colleagues, who opted to stay in Karnataka after retirement, miss him dearly due to this vanishing act; yet wish him and family all the best and long retired life. A loss to Karnataka is a gain to West Bengal.

Dr. Kodira A. Kushalappa
IFS-RR 1968

J.

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